RESEARCH ON WILDFIRE HAZARD REDUCTION IN PONDEROSA PINE ECOSYSTEMS AT GRAND CANYON NATIONAL PARK

COCONINO COUNTY · ARIZONA

Summary

The condition of Grand Canyon National Park's (GRCA) ponderosa forests has been greatly altered since the late 1800s. Historically, small numbers of large old ponderosa pines dominated these forests and frequent, low intensity fires burned duff and seedlings from the forest floor but left most of the mature trees unharmed. This changed when livestock grazing and intentional fire suppression interrupted the natural fire regime. Today, extensive areas of the forest are dominated by dense stands of small trees making them more susceptible to disease, insect infestation, and high intensity wildfires. Carefully monitored, long-term experiments are needed in order to evaluate the short- and long-term effects of reintroducing fire to ponderosa pine ecosystems after long periods of fire exclusion. Through carefully designed scientific studies comparing before-and-after treatments, and long-term monitoring of treatment and control sites, the Park will gain information that can be used to refine fire management practices and preserve the Park's forests.

This Environmental Assessment/Assessment of Effect (EA) analyzes the impacts of three fire management research alternatives at GRCA: A) a no-action alternative; B) the alternative based on a research design developed by Northern Arizona University; and C) the agency preferred/environmentally preferred alternative. Impacts to natural, cultural, socioeconomic, and wilderness resources, visitor use, and Park operations are described in this document. The preferred action is a research project designed to test four management prescriptions on two small-scale (80-acre) experimental blocks. Fire suppression and current fuels reduction approaches using prescribed fire (fire alone) would be compared with two fuels reduction approaches that involve thinning of small-diameter trees followed by prescribed burning. The preferred action is a revised set of treatments designed to address public comments received on an EA that was released for public review in January 1999, entitled *Grand Canyon Forest Restoration Research*. The treatments described in the preferred action focus on wildfire hazard reduction and resource protection, specifically for preserving old trees. Information gained through this research would enable the Park to reevaluate and refine current fire management practices and guide future management decisions, including the Park's Fire and Resource Management Plans. We expect that any thinning prescriptions developed as a result of this research would be applied selectively (specifically at wildland-urban interfaces, burn unit perimeters, and Park boundaries, and to protect sensitive natural and cultural resources), and would not be applied over broad areas of the Park.

Public Comment
To view the EA, including references and appendices, access the following web site: *www.nps.gov/grca/forest/*.

If you wish to comment on the EA, you may mail comments to this address:
Joseph F. Alston, Superintendent
Attention: Sara White, Compliance Officer
Wildfire Hazard Reduction Research
Grand Canyon National Park, P.O. Box 129
Grand Canyon, AZ 86023

This EA will be on public review for 45 days. The purpose of this comment period is to seek comments and additional information that might pertain to the three alternatives presented. Substantive public and agency information and comments received through this comment period will be considered in the final decision document. Please note that names and addresses of people who comment become part of the public record. **If you wish us to withhold your name and/or address, you must state this prominently at the beginning of your comment.** We will make all submissions from organizations, businesses and individuals identifying themselves as representatives or officials of organizations or businesses available for public inspection in their entirety.

ENVIRONMENTAL ASSESSMENT
RESEARCH ON WILDFIRE HAZARD REDUCTION
IN PONDEROSA PINE ECOSYSTEMS AT GRAND CANYON NATIONAL PARK

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I. PURPOSE AND NEED FOR THE PROPOSED ACTION

PURPOSE AND NEED

Scientists generally agree that a frequent, low intensity fire regime played a significant role in maintaining relatively open conditions in Southwestern ponderosa pine (*Pinus ponderosa*) forests by controlling tree population densities and forest floor litter accumulations (Cooper 1960, Kilgore 1981, Swetnam and Betancourt 1990, Covington et al. 1994, Swetnam and Baisan 1994). Human-caused changes, such as livestock grazing and fire suppression, have disrupted fire cycles and resulted in irruptions, or sudden increases, in tree population. This in turn has led to steadily increasing accumulations of fuel on the forest floor, reduced tree vigor, and conversions of vegetation from fire adapted species to fire intolerant species.

Other changes attributed to the change in the normal fire cycle include decreased understory vegetation, an increased likelihood of insect and disease outbreaks, and increased potential for and instances of high intensity wildfires. If current trends continue, large tracts of forest will be lost to disease, drought, and fire (Covington and Moore 1994, Covington et al. 1994, Covington et al. 1997b, Fulé et al. 2000). Despite the relative consensus among scientists and natural resource professionals that continuation of this situation is unwise, methodologies appropriate for returning "natural" forest function and process are the subject of considerable debate (Covington et al. 1994, Fiedler et al. 1996, Harrington 1996, Miller 1996).

As a result of long-term changes to Grand Canyon National Park's GRCA forests, we face fire conditions that are hazardous to life, property, and sensitive resources. We are working to address these conditions through the Park's ongoing fire program. As explained in GRCA's Resource Management Plan (USDI National Park Service 1997) "Fire research initiated in the 1970s identified more clearly the adverse effects caused by suppression, and in 1978 a management plan was developed and approved allowing for the first time fires to burn under an established set of conditions. The Yellowstone fires in 1988 ushered in a new era, new fire management policies, and considerable funding both for suppression and prescribed burning. Since that time there has been an increase in fire management staff professionalization, and development of an aggressive prescribed fire policy."

In August 1997, National Interagency Fire Center personnel visited the Park to evaluate fire hazards and offer suggestions. The report from that visit (Botti et al. 1997) states "The park and adjacent national forest have recognized for some time that the North Rim forests have an unnaturally dense growth of understory trees due to the suppression of lightning fires and the cessation of aboriginal ignitions in the late nineteenth century. The continued encroachment of these 'ladder' fuels under what was naturally an open canopy of pines and firs, together with the heavy accumulation of dead and downed fuels, has created the potential for widespread crown fires that will further disrupt the natural ecosystem and endanger public safety, cultural resources, park facilities, and market resources on the Kaibab National Forest....It has yet to be proven that either prescribed burning alone or in combination with mechanical treatments can correct the fuels problem quickly enough to prevent large, catastrophic wildfires. However the risks of no action far outweigh the risks of prescribed fire or mechanical thinning. There is no doubt that without intervention to modify the fuels complex, an unnatural and catastrophic wildfire will sweep across tens of thousands of acres on the North Rim within the next few years."

During the summer of 2000, severe and extensive fires occurred in many Western states, leading the President to ask the Secretaries of the Interior and Agriculture to prepare an analysis of needed actions and requirements. Their report "...focused on several key points: restoring landscapes and rebuilding communities, undertaking projects to reduce risks, working directly with communities, and establishing accountability. The Congress expressed its support with substantial new financial resources...along with direction for aggressive planning and implementation to reduce risks of wildland fire in Wildland Urban Interface areas" (USDI 2001).

The purpose of this research is to compare four fire management approaches in GRCA. The proposed treatments are aimed at safely managing hazardous forest fuels while protecting old trees and other resources.

There is a constant need for new management applications for reducing and containing undesirable wildfire (Nichols et al. 1994). This research would compare prescribed fire alone and fire suppression to two levels of thinning of small-diameter trees followed by prescribed burning. Furthermore, this research would provide information on treatments designed to meet both fire management and ecological objectives for safely returning more natural fire regimes to the landscape. It is unlikely that any single method would meet all objectives for hazard fuels reduction and preservation of vegetation, wildlife habitat, air quality, and wilderness. This research would not establish Park fire management policies, which is done through development of fire management plans. Rather, this research would help refine our current practices of thinning and burning and would evaluate methods for protecting sensitive resources. The experiment would be successful if it provides information on both wildfire hazard reduction and resource benefits, specifically information on: effects on fuel loads (both live fuels and coarse woody debris); progression of current conditions toward desired future conditions (see Appendix A); and changes in the condition of currently stressed large, old trees, of shrubs and herbs of the understory, and of exotic plant species.

Results of this research would be used to evaluate and refine techniques to reduce hazardous fuels in pine/oak and pine/fir communities for:
1. wildland-urban interface fuel treatments;
2. preparation of defensible perimeters for burn units;
3. reducing wildfire spread beyond Park boundaries;
4. protection of sensitive natural and cultural resources.

The scope of this research project does not include sub-alpine mixed conifer forests or pinyon-juniper woodlands. We also do not expect thinning to be applied over broad areas of the Park in the future.

GRCA's General Management Plan (USDI National Park Service 1995a) called for studies to determine the natural fire regime for plant communities and the effects of fire exclusion and prescribed fire on Park wildlife and vegetation communities. Because of different management histories, experimental data from surrounding areas are not as useful as site-specific data obtained within the Park. This is a National Park Service (NPS) project. Northern Arizona University (NAU) is assisting the Park by helping to evaluate the effects of these treatments on vegetation and forest fuels. To help the Park to begin to address forest conditions at GRCA, NAU's College of Ecosystem Science and Management submitted a draft research proposal entitled *Grand Canyon Forest Ecosystem Restoration* to the United States Department of Interior's (USDI) Fire Coordination Committee. The Fire Coordination Committee's Research Working Team granted funding in the amount of $925,000 on February 20, 1997 to proceed with two distinct phases of the proposal.

In the first phase, NAU's 1997 research proposal included study of fire history and the historic range of natural variability of forest vegetation and structure for two 3,000-acre study units on the North and South Rims of GRCA. This portion of the research was permitted under a categorical exclusion (see Appendix B) and has been completed.

NAU's 1997 research proposal also included a second phase that would test three restoration treatment methodologies: burning alone, thinning followed by burning, and no treatment. The Park distributed the proposal for extensive peer review and worked with NAU to revise the proposal to include a fourth treatment, minimal thinning, followed by burning (Covington et al. 1997a). NAU's revised research proposal was the basis for Alternative "B". A draft EA based on NAU's revised research proposal, entitled *Grand Canyon Forest Restoration Research,* was also submitted for public review in January 1999.

Based on an evaluation of the comments received about the draft EA, Park staffs have developed Alternative "C". This is the agency preferred and environmentally preferred alternative (preferred action). Under this treatment, fewer and smaller trees would be thinned and no wood would be removed from the sites. With Alternative "C" the Park has focused on methods for protecting old trees while implementing prescribed fire. Wildfire hazard reduction and resource protection have always been inherent to the project, but this research takes a more incremental approach to fuels reduction than had been described in Alternative "B".

The advantages of Alternative "C" are that it addresses concerns related to tree thinning in parks, eliminates ecological and aesthetic damage associated with skid trails and landings, would be relevant for roadless areas, and provides a longer time period to assess initial results. Disadvantages of this approach are that treatments may need to be repeated to accomplish fuel reduction objectives, and it takes longer to assess progress. This EA evaluates the impacts of the Alternative "C" (preferred action) and compares it to Alternative "A" (no action) and Alternative "B" (see Appendix F).

Specifically, the NPS proposes to complete experimental treatments on a total of 160 acres in GRCA (Covington et al. 2000a, Revised Work Plan, Appendix C). Both the North and South Rim 80-acre experimental blocks would be divided into four 20-acre experimental units. Treatments would be randomly assigned to each experimental unit. The Park's staff would supervise the completion of all experimental treatments. The preferred experimental treatments are described below.

1) **Intermediate Thinning and Burning Treatment (Intermediate Treatment).** One 20-acre unit on both the North and South Rims (total of 40 acres) would undergo an intermediate treatment. Under this treatment, all trees less than 5 inches diameter at breast height (dbh, typically cited as 4.5 feet above ground level) would be cut, except those needed for replacement of lost presettlement trees. The thinning would be followed by prescribed fire treatments.

2) **Minimal Thinning and Burning Treatment (Minimal Treatment).** One 20-acre unit on both the North and South Rims (total of 40 acres) would undergo a minimal treatment. Under this treatment, thinning would be targeted around individual presettlement-age trees. Trees with a dbh of 5 inches or less, within a predetermined distance around all presettlement-age trees, would be cut. The maximum thinning distance is equal to the average height of the canopy within 40 feet surrounding the target tree, with a minimum of 40 feet. For example, if the average canopy height were 50 feet, thinning would extend out to 50 feet from the target tree (see Figure 1, page 16). The thinning would be followed by prescribed fire treatments.

3) **Burn-only Treatment.** One 20-acre unit on both the North and South Rims (total of 40 acres) would undergo a burn-only treatment. No trees on these units would be cut except when required to mitigate specific hazards to safe prescribed burning. The units would only be treated with prescribed fire.

4) **Control.** One 20-acre unit on both the North and South Rims (total of 40 acres) would serve as a control. Under this treatment no trees would be thinned, and fire would continue to be excluded from the unit.

Alternative "C" (preferred action) differs from Alternative "B" on the following points:

1. A 5-inch limit would be placed on trees to be thinned. A small diameter limit would: enable all thinned material to be left on site as slash, be applicable to roadless areas, eliminate need for skid trails or landings, be more feasible with hand tools, and accomplish research objectives.
2. No wood would be utilized for any purpose or removed from the experimental sites. The thinned trees would be broadcast burned or burned in piles. GRCA fire staff would make a determination of what technique would be used to safely burn this slash.
3. Two years after burning, the effectiveness of the 5-inch limit and other aspects of the treatments would be assessed.
4. No mechanized equipment would be used for thinning on the North Rim site, proposed for wilderness status.
5. No road improvements, skid trails, or landings would be needed or constructed.
6. Litter and duff would be raked away from presettlement trees in the two thinning treatments, but not in the burn-only treatment. This would allow the burn-only treatment to serve as a better comparison to current management practice.

SCOPING PROCESS

In January 1997, NAU's College of Ecosystem Science and Management submitted a draft proposal entitled "Grand Canyon Forest Ecosystem Restoration" to the USDI's Fire Coordination Committee. This proposal suggested a test of three treatment methodologies: burning alone, intense thinning to presettlement levels followed by burning, and no treatment. This proposal was extensively peer-reviewed and comments by a number of reviewers were collected and summarized by GRCA staff. A revised proposal incorporating GRCA's request for a fourth treatment approach of minimal thinning, followed by burning, was submitted by NAU College of Ecosystem Science and Management to GRCA and the Kaibab National Forest on June 12, 1997 (Covington et al. 1997a). The proposed treatments on the Kaibab National Forest were covered under existing planning and compliance, and have already been completed by U.S. Department of Agriculture (USDA), U.S. Forest Service (USFS)(Fulé et al. 2001).

In August 1997, an interagency group toured the proposed sites and the existing, relatively large-scale restoration treatment areas on Bureau of Land Management (BLM) administered land on Mount Trumbull, to view the results of the full restoration treatment in a similar ecosystem. On March 16, 1998, GRCA staff held a workshop on the NAU campus that was attended by non-governmental organizations with known interests in management of federal forest lands. These organizations were briefed on the status of the proposal and were asked to identify their issues and concerns. They filed a report recommending testing of restoration techniques.

On April 27, 1998, a scoping letter concerning this project was sent to groups and individuals that were expected to have an interest in this project. A 30-day comment period was thus opened in which the Navajo Nation, the Southwest Center for Biological Diversity, the Arizona Department of Environmental Quality, and two individuals responded with comments.

On January 22, 1999 a draft EA was released. Comments were accepted on the draft EA until March 25, 1999. On February 11, 1999 a public meeting was held in Flagstaff, Arizona to solicit additional statements and comments concerning the proposal, draft Work Plan, and the associated draft EA. A second public meeting was held in Kanab, Utah on February 12, 1999 for the same purpose. See Appendix D for a summary of public comments and NPS responses.

This EA will be released for a 45-day comment period. The purpose of this comment period is to seek comments and additional information that might pertain to the three alternatives presented. Substantive public and agency information and comments received through this comment period will be considered in the final decision document.

ISSUES

Issues and concerns about this proposal were identified in past NPS and GRCA planning efforts, in meetings with Park managers and staff, university researchers, and environmental groups, and input from other state and federal agencies. Issues were also identified based on federal laws, regulations, and orders. These include NPS Management Policies (USDI National Park Service 2001) and Natural Resources Management Guidelines (USDI National Park Service 1991). Other issues were generated from NPS knowledge of limited or easily impacted resources, and from concerns expressed by the public or other agencies during previous planning projects at GRCA and elsewhere. Issues to be addressed in this EA include the following nine topics:

Air Quality. GRCA is a Class 1 air quality area, with the most stringent protection. Air quality and related visibility are significant issues at GRCA. Wildfire, prescribed burning, and burning of slash have both short- and long-term impacts on air quality.

Biotic Communities. The 1969 National Environmental Policy Act (NEPA) requires an examination of the impacts on the components of affected ecosystems. The ponderosa pine forest and mixed conifer forest

community types would be the most affected, thus impacts to these community types, as well as the preservation of old-growth forests will be examined in this document. Potential impacts to threatened and endangered species, and species of concern will also be examined under this issue. Finally, potential impacts of non-native plants will be examined under this issue. Executive Order 13112 requires federal agencies to consider the effects of their actions on non-native species. Data from this research would help assess the potential impacts of forest management treatments on non-native species.

Cultural Resources. The 1966 National Historic Preservation Act (16 USC 470 et seq.) as amended in 1992, NEPA, the 1916 NPS Organic Act, Management Policies 2001, NPS-2 (Planning Process Guideline), DO-28 (Cultural Resource Management Guideline), and the 1990 Native American Graves Protection and Repatriation Act require the consideration of impacts on cultural resources. Consultation with the State Historic Preservation Office and affiliated American Indian tribal governments is also mandated.

Impairment. In addition to determining the environmental consequences of the three alternatives, NPS policy (USDI National Park Service 2001) requires analysis of potential effects to determine whether or not actions would impair park resources. The fundamental purpose of the national park system, established in the Organic Act and reaffirmed by the General Authorities Act, as amended begins with a mandate to preserve park resources and values. NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values. Congress has given the NPS management discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of the park. However, this discretion is limited by the statutory requirement that the NPS must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise. The prohibited impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. An impact to any park resource or value may constitute impairment. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the park or to the opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning document. Impairment may result from NPS activities in managing the park, visitor activities, or activities undertaken by concessionaires, contractors, and others operating in the park.

Park Operations. Data collected from this research would help with planning for future fire management actions at GRCA. High fuel loads and dense forest conditions at GRCA make the objectives of the prescribed fire program more difficult to achieve. The Maintenance Division may need to repair damage to primitive roads caused by vehicles used in this project. Science Center employees would be involved in implementing and monitoring this project as a normal part of their programs.

Socioeconomic Environment. This project may provide some benefit to the local economy by providing employment.

Soil and Water. Thinning and burning operations on the experimental blocks may affect soil and water. Prescribed burns, wildfire, and thinning operations affect erosion, soil oxidation and sterilization, soil compaction, and water runoff.

Visitor Use and Experience. The 1916 NPS Organic Act and the Management Policies 2001 state that the NPS will promote and regulate the use of parks and provide those services necessary to meet the basic needs of park visitors, provide for public enjoyment, and achieve each park's management objectives. This forest management proposal, which includes thinning and burning operations, may affect enjoyment by Park visitors.

Wilderness. NPS Management Policies require that lands identified as suitable for wilderness designation will be managed to preserve wilderness character and values undiminished until Congress acts on a recommendation. Over one million acres of GRCA have been proposed for wilderness designation. Part of

the North Rim experimental block is included in this proposed wilderness area. Treatment activity has the potential to affect wilderness character and values (see pages 64-65).

ISSUES/TOPICS CONSIDERED BUT DISMISSED

The rationale for dismissing specific topics from further consideration is given below.

Prime and Unique Farmlands. In August 1980, the Council on Environmental Quality (CEQ) directed that federal agencies must assess the effects of their actions on farmland soils classified by the USDA's Natural Resources Conservation Service (NRCS) as prime or unique. Prime or unique farmland is defined as soil that particularly produces general crops such as fruits, vegetables, and nuts. According to NRCS, none of the soils in the project areas are classified as prime and unique farmlands. Therefore, the topic of prime and unique farmlands was dismissed as an issue in this document.

Environmental Justice. Executive Order 12898, "General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. The proposed action would not have health or environmental effects on minorities or low-income populations or communities. Therefore, environmental justice was dismissed as an issue in this document.

Tourism. This project is not expected to interfere with the tourism-based economy. There would be short periods when roads were closed for prescribed burning, however this would not be any longer than other fire management activities would otherwise need.

RELATIONSHIP TO PREVIOUS, CURRENT, AND FUTURE PLANNING EFFORTS

The proposed action would partially implement the approved GRCA 1995 General Management Plan (GMP)(USDI National Park Service 1995a) and 1997 Resource Management Plan (RMP)(USDI National Park Service 1997). The GMP calls for the restoration of the natural role of fire in park ecosystems within the constraints specified in the Park's Fire Management Plan (USDI National Park Service 1992a). The RMP notes the need for forest ecosystem restoration to: 1) protect human life and property; 2) restore ecosystem structure and forest fuel loads to within the natural range of variability in vegetative communities; 3) restore fire as a natural process; and 4) reduce fuels to levels that allow additional acreage to be designated as wildland fire use for resource benefits areas (formerly known as prescribed natural fire areas).

The GRCA Strategic Plan (USDI National Park Service 1995b) outlined the additional goals of establishing a scientific and scholarly basis for resource management decisions and strengthening protection of Park resources. The importance of scientific inquiry in decision making is also reflected in the Park's Resource Management Plan (USDI National Park Service 1997) and Fire Management Plan (USDI National Park Service 1992a).

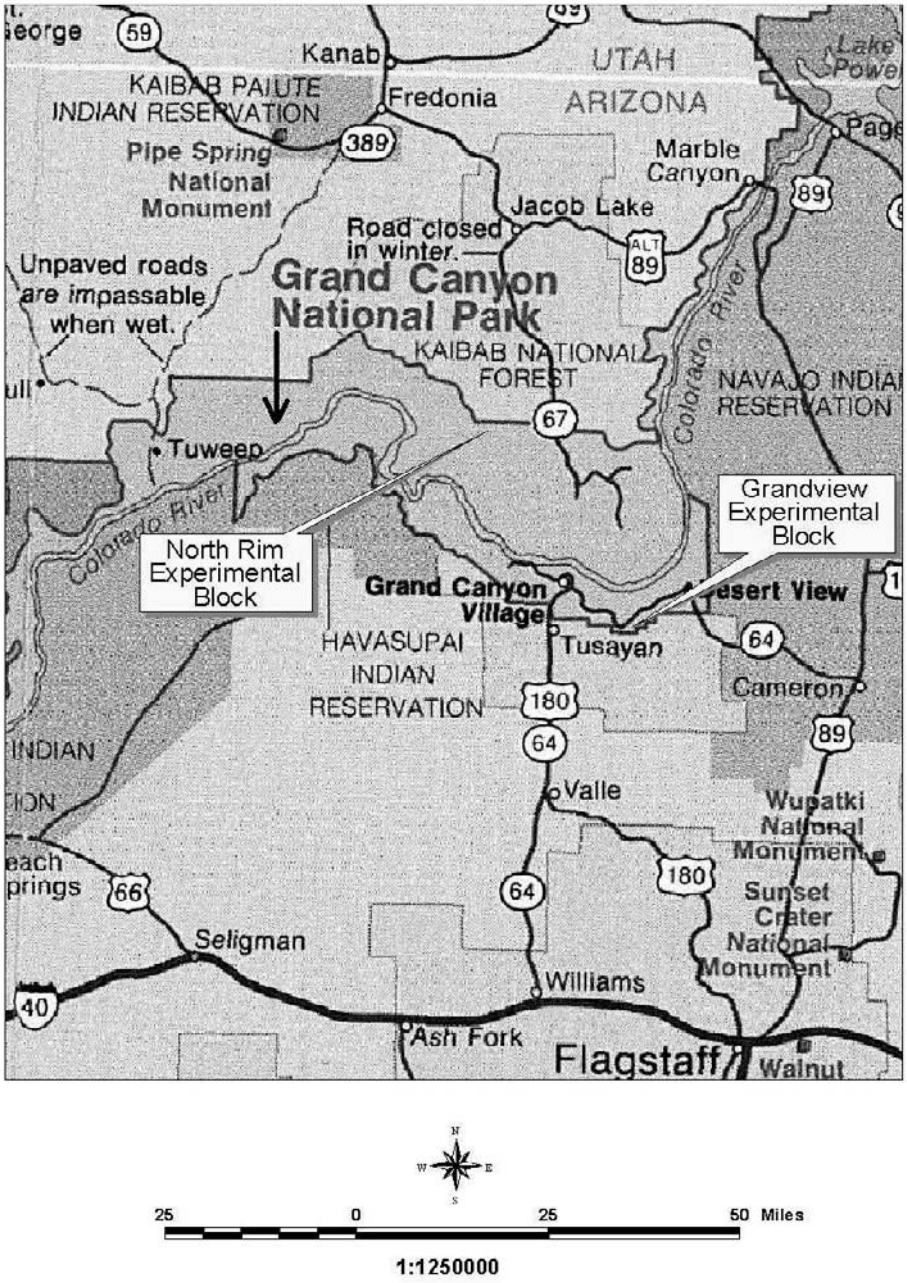
II. ALTERNATIVES CONSIDERED

There are many possible approaches for reducing wildfire hazard in ponderosa pine forests. However, only three alternatives are analyzed in this EA: Alternative "A" (no action); Alternative "B" (the original research alternative); and Alternative "C" (the preferred action and the same as the agency-preferred and the environmentally-preferred alternative)(see Appendix F).

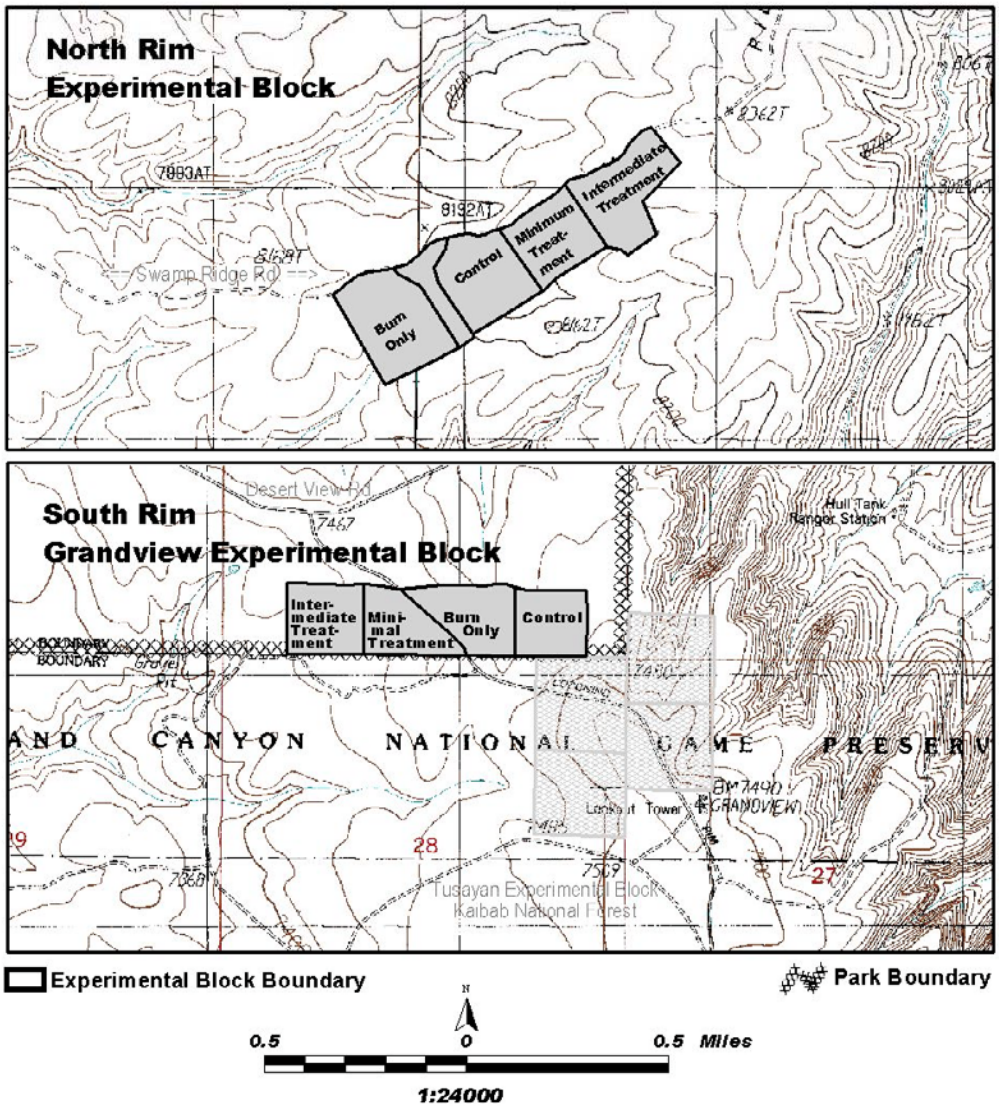
PROJECT LOCATION

This project is located in Grand Canyon National Park, Coconino County, Arizona (see Maps 1 & 2, pages 7-8).

Map 1. Wildfire Hazard Reduction Research project locations in Grand Canyon National Park.



Map 2. North Rim and South Rim (Grandview) Experimental Blocks.



II. A. ALTERNATIVE "A" (NO ACTION)

As required by NEPA and NPS policy, an analysis of no-action is included for comparison purposes in this assessment. Under Alternative "A", data would not be collected at GRCA on potential methodologies for management of ponderosa pine ecosystems. Current conditions and values would be maintained. Routine, planned land management practices would continue on the experimental blocks. The forest communities on the North and South Rim experimental blocks would continue to be managed under the Park's Fire Management Plan (USDI National Park Service 1992a). To that end, the experimental blocks would be managed under a policy of wildland fire use, where naturally occurring fires would be monitored and allowed to burn if conditions were within prescribed limits. Hazardous fuel loads and the potential of stand replacement fires would continue to exist on the untreated experimental blocks until fuels were reduced by wildland fire or other means, especially the denser North Rim site.

II. B. ALTERNATIVE "B" - *CONSIDERED BUT NOT PROPOSED*

The treatments outlined in NAU's original research study plan are described under this alternative (Covington et al. 1997a). Under this alternative, two 80-acre project blocks on the North and South Rims would be divided into four 20-acre units. Each of the four units would undergo one of three levels of treatment or serve as the control. The treatments include: 1) a full restoration treatment that includes mechanical thinning to emulate presettlement forest structure, followed by prescribed burning; 2) a minimal thinning treatment to reduce fire hazard, followed by prescribed burning; 3) a prescribed fire only treatment; and 4) a control or no treatment unit. Guidelines and criteria for each treatment are described in more detail below.

II. B.1. FULL RESTORATION TREATMENT

The primary goal of the full restoration treatment would be to restore ponderosa pine forest structure to the approximate conditions at the time of disruption of the natural fire regime. This would entail recreating, as much as possible, the density, spatial distribution, and natural range of variability of living trees of all species that were present prior to fire exclusion beginning in approximately 1870 (Covington et al. 1997a, 1998a). This goal would be reached via thinning and burning. Four objectives would guide the full restoration treatment prescription:

1. Recreate presettlement tree density by conserving all living trees of all species that were present prior to fire exclusion beginning in approximately 1870, including preservation of sufficient numbers of large postsettlement trees to replace subsequent mortality of these presettlement trees.
2. Restore the spatial pattern of the presettlement forest by retaining all living presettlement trees (pre-1870) and locating replacement trees in close proximity to dead presettlement trees.
3. Maintain a wide range of age classes by retaining all living presettlement trees, thereby conserving genetic variability to the greatest extent possible. By conserving all living presettlement trees as well as suitable replacement trees, an uneven aged stand would be retained with trees of ages spanning several hundred years.
4. Maintain tree health by selecting healthy, vigorous replacement trees.

The following criteria would guide the implementation of the full restoration treatment.

Cutting

Under the full restoration treatment, all postsettlement trees with the exception of replacement trees, would be mechanically thinned. Chainsaws would be used to cut approximately 3,600 trees on the North Rim and 4,300 trees on the South Rim full restoration treatment units. See Appendix E for data on the number of trees in the treatment units.

Treatment of Cut Material

Thinned trees would be removed to prevent undesirable fire effects and to allow understory plants to regenerate. No commercial use of the material would be made. Larger material (fuelwood size of 5-12 inches

dbh) would be cut and transferred to the Bureau of Indian Affairs (BIA), to be distributed for use as firewood by local Native American communities.

The December 1998 Work Plan selected the use of horse-drawn logging equipment to move the material from the interior of the units to the existing roads as the preferred method to move wood off of the North Rim site.

Slash generated by the full restoration treatment would be broadcast or pile burned (see page 15 of Appendix C). See below for a description of post-thinning prescribed burning.

The following specifications would apply to BOTH the full restoration and minimal thinning treatments.

Marking
A combination of paint and flagging would be used to mark "leave" trees to be retained. Trees along the experimental unit's boundaries would also be marked to aid in maintaining future fire lines. See page 12 of Appendix C for more information on marking.

Access
The experimental blocks are intentionally located next to existing roads. No new road construction or upgrading would occur under these treatments, however, skid trails and landings would be necessary for these treatments. Skid trails are routes used to skid or drag trimmed logs from the stump to a landing or road. Landings are open areas where logs or other forest materials are aggregated and stored until they can be removed from the site.

The following eight specifications would apply to BOTH thinning and burning treatments - the full restoration and minimal thinning treatments of Alternative "B" (§ II.B.1 and II.B.2) and the intermediate and minimal treatments of Alternative "C" (§ II.C.1 and II.C.2).

Identification of Presettlement Age Trees
All trees not meeting the criteria described below or not retained as a replacement tree would be thinned. See page 32 of Appendix C for information on determining age of ponderosa pine, Gambel oak (*Quercus gambelii*), juniper (*Juniperus osteosperma*), pinyon (*Pinus edulis*), Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*) and aspen (*Populus tremuloides*).

Selection of Replacement Trees
Selection of replacement trees (apart from presettlement trees of all species, all of which are retained) should favor larger, older trees, that appear capable of surviving for a normal lifetime. Except when conditions seem likely to cause premature mortality, replacement trees should not be cut due to species, tree form, disease, herbivory, or damage from lightning, wind, or snow. Species composition in replacement trees should favor the presettlement composition, as observed from the living and dead presettlement trees on the site. For guidelines in selecting replacement trees by species, see pages 24-25 of Appendix C.

Fireline
Firelines are necessary to prevent fire from spreading into or away from the experimental blocks. Fireline would be established around each 80-acre experimental block and around the control within each block. Although, the experimental blocks were laid out to take advantage of existing roads and firelines, additional fireline may be constructed. Additional fireline preparation would be under the direction of GRCA fire management personnel.

Presettlement Tree Protection
Heat from prescribed burns has been documented to be a major cause of mortality of old-growth (presettlement) ponderosa pine trees (Ryan and Frandsen 1991, Swezy and Agee 1991, Sackett et al. 1996, Covington et al. 1997a). Lethal temperatures develop in deep duff layers, which have accumulated over extended periods of fire exclusion. Because old-growth trees are important to the ecosystem, ensuring their

survival through the course of the treatment is a high priority. Old-growth tree protection would be undertaken on the full and minimal treatment units. Old-growth tree protection would not be undertaken on the burn-only units so that this treatment would better represent current management practice. Similar protection would be provided for old-growth snags. For more information on old tree protection, see pages 10-11 of Appendix C

Stumps
All stumps would be cut flat and as low to the ground as possible. Stump heights should be 3 inches or less, but this standard may not always be met due to nearby rocks or safety concerns. Stumps would be left to decompose or be consumed by fire.

Post-thinning Prescribed Burning
A prescribed burn, based on GRCA FMH-4 Monitoring Type Description Sheet (Appendix A), would be conducted upon completion of the thinning treatments. Site specific prescriptions would be developed to emulate presettlement fire regime characteristics on three treatment units. After the first burn, the three treatment units would be re-burned at intervals similar to the presettlement fire regime. The control would not be burned over a long-term monitoring period.

Post-treatment Restoration
Restoration of understory vegetation through natural succession is strongly preferred in order to maintain the genetic diversity and integrity of the ecosystem (USDI National Park Service 1991). However, researchers and GRCA staff would make an assessment of the recovery potential of each experimental block both before and after treatment. If a consensus were reached that revegetation would be required to prevent erosion or limit the spread of non-native pioneer species, then exclusively native seed sources with the most local source possible would be used. The mix of plant forms, functional groups, and species would be selected to match the best available understanding of the presettlement ecosystem structure. More than one thinning treatment may be needed to remove accumulated fuels. The need for repeat treatments, if any, would be determined through post-treatment evaluation.

Post-treatment Monitoring
Future changes in the condition of the treated area need to be considered. Because most of the unthinned trees would be large enough to survive prescribed fires and many wildfires, their continued and accelerated growth in the thinned stand would tend to increase fire and competitive hazards for the target tree over time. Consequently, management would continue to need resource data to guide future decisions. Post-treatment monitoring would be carried out at 1, 2, and 5 years.

II. B.2. MINIMAL THINNING TREATMENT

The primary goal of the minimal thinning treatment would be to begin to restore ponderosa pine forest structure. This would entail beginning to recreate the density, spatial distribution, and variability of trees prior to the time of disruption of the frequent fire regime, estimated at 1870. Five objectives would guide the minimal thinning treatment:

1. Use prescribed fire as an integral component of the minimal thinning treatment.
2. Target thinning around individual presettlement trees (target trees). Fuel structures would be designed so that a crownfire cannot cross to the target tree, and the fire intensity of any wildfire at that tree is low enough to avoid mortality. To minimize fire behavior around the target tree, thinning intensity must be greatest close to the tree. Different thinning intensities in three concentric circles or ellipses around each tree alter fuels, breaking the intensity of fires, permitting the target tree to survive.
3. Focus thinning on the smallest and youngest trees. Presettlement trees would not be removed. Wherever possible, the largest trees would be left, especially where such trees would have been selected as replacements for dead presettlement trees in a full restoration prescription. In no case, would more trees be thinned under minimal thinning prescription than would have been removed under a full restoration prescription on the same unit.
4. Minimize the threat of crownfire by intensely thinning fuel ladders and dense young tree stands with interlocking canopies around the target tree. Thinning would decrease moving away from the target tree.

5. Monitor and adapt management actions according to future changes in the condition of the treated area. Most of the remaining trees on the unit would be large enough to survive prescribed fires and wildfires. Their growth is likely to accelerate as nutrients are released by burning, competition for soil moisture and sunlight is reduced through thinning. Consequently, crowding and fire hazards can be expected to increase unless additional treatments occur.

The following specifications would apply to the minimal thinning treatment.

Thinning Prescription
The target trees would be the focus of thinning to reduce fire behavior around them. Marking would ensure that all living presettlement trees are identified and retained, and would identify postsettlement replacement trees which would not be removed during the minimal thinning treatment. In contrast to the full restoration treatment, only a portion of the unmarked trees in the minimal thinning treatment would be removed according to the following guidelines.

Thinning intensity would vary around each target tree, with three different levels of thinning at radii of 15 feet, 15-30 feet, and 30 feet to the maximum thinning distance. These different thinning intensities around each tree would alter fuels, breaking the intensity of fires, permitting the target tree to survive.

Within a radius of 15 feet, only the target trees would be retained. Forest floor fuels would be raked away from the target tree bole for 18-24 inches. In addition, other large fuels or slash would be pulled away from below the target tree crown.

Between 15 and 30 feet, the goal is to create an open presettlement like forest. Thinning in this area would remove most of the unmarked trees. At this level of thinning, more trees would be retained than in the closest circle. Trees would be retained individually or in groups. Fuel ladders would be removed.

The maximum thinning distance is equal to the average height of the canopy within 40 feet surrounding the target tree, with a minimum of 40 feet. For example, if the average canopy height were 50 feet, thinning would extend out to 50 feet from the target tree. In the outer circle between 30 and 50 feet, the thinning intensity would be least. The goal of thinning in this area is to create a transition between the surrounding forest and the inner thinned circle. Although fewer trees would be removed, thinning would still focus on breaking up fuel ladders and separating groups of trees.

Thinning patterns need to be adjusted for slope and wind direction to account for more intense fire behavior as fires move upslope and with the wind. For slopes > 10%, the distance of each thinning level would be extended about 15-30% in the downslope direction from the target tree, and in the upwind direction of the prevailing fire season winds (west and south). For changes in prevailing wind direction, corresponding adjustments in thinning patterns would be made in the upslope and downwind (north and east) directions.

Cutting
Trees meeting the minimal thinning treatment's cutting criteria would be mechanically thinned. Chainsaws would be used to cut approximately 3,100 trees on the North Rim and 5,000 trees on the South Rim minimal thinning treatment units (see Appendix E). (Note: There are more small trees present on the minimal thinning unit, than on the full restoration unit.)

Treatment of Cut Material
Thinned trees over 5 inches dbh would be removed to prevent undesirable fire effects and to allow understory plants to regenerate. No commercial use of the material would be made. Larger material (fuelwood size of 5-12 inches dbh) would be cut and transferred to the BIA, to be distributed for use as firewood by local Native American communities. Slash generated by minimal thinning treatments would be broadcast or pile burned (see page 15 of Appendix C).

Marking
See page 10 for marking of leave trees on the minimal thinning unit.

Access
See page 10 for access to the minimal thinning unit.

Identification of Presettlement Age Trees
See page 10 for identification of presettlement age trees for the minimal thinning treatment.

Selection of Replacement Trees
See page 10 for selection of replacement trees for the minimal thinning treatment.

Fireline
See page 10 for firelines around the minimal thinning unit.

Presettlement Tree Protection
See pages 10-11 for presettlement tree protection for the minimal thinning treatment.

Stumps
See page 11 for the treatment of stumps on the minimal thinning unit.

Post-thinning Prescribed Burning
See page 11 for post-thinning prescribed burning on the minimal thinning unit.

Post-treatment Restoration
See page 11 for post-treatment restoration burning on the minimal thinning unit.

Post-treatment Monitoring
See page 11 for post-treatment monitoring on the minimal thinning unit.

II. B.3. BURN-ONLY TREATMENT

As noted above, one 20-acre unit on both the North and South Rim research sites (total of 40 acres) would undergo a burn-only treatment. This treatment is intended to represent the current fire management objectives at GRCA (USDI National Park Service 1992a). The specific details of the burn treatment would be described in a site-specific burn plan based on the GRCA Fire Monitoring Handbook (sheet 4) Monitoring Type Description Sheets (Appendix A). For safe and effective treatment, burn plans are developed as close to the time of treatment as possible, and are not included in this document. If possible, the burn-only units would be burned at the same time under the same conditions as the other units. Consideration would be given to the fact that there would be lighter ground fuels on these units due to the absence of slash but relatively greater live tree fuels due to the absence of thinning (USDI National Park Service 1992a).

II. B.4. CONTROL

One 20-acre unit on both the North and South Rim research sites (total of 40 acres) would serve as a control and would not receive any treatment. The control unit would be protected from wildfire, prescribed burning, and the effects of thinning. Control unit boundaries would be clearly flagged during thinning operations and the presence and purpose of the control unit would be made clear to thinning operators and prescribed burn planners. No vehicle or equipment use would be permitted within the control units.

The control units would also be protected from the first and subsequent prescribed burning treatments with a secure fireline. Because the need to protect the controls would be long-term, a relatively permanent fireline would be constructed around the control units. Maps of the control unit locations would be provided to GRCA fire managers and other resource managers to ensure their protection from future wildfire, prescribed fire, and other management activities.

II. C. ALTERNATIVE "C" (PREFERRED ACTION)

Based on an evaluation of comments received after the release of the draft Forest Restoration Research EA (USDI National Park Service 1999b), GRCA staff worked with NAU researchers to develop a third research alternative. This is now the agency-preferred alternative, and it is synonymous with the environmentally-preferred alternative. The new alternative better addresses social concerns about forest thinning, reduces potential soil disturbance, and is more applicable to roadless and proposed wilderness areas. The preferred action consists of three levels of treatment and a control. These treatments are intermediate, minimal, and burn-only.

PROJECT LOCATION
This project is located in Grand Canyon National Park (see Maps 1 & 2, pages 7-8) at the same sites as Alternative "B" described above.

II. C.1. INTERMEDIATE TREATMENT

As noted above, each 20-acre unit on both the North and South Rim sites (total of 40 acres) would undergo an intermediate treatment. The intermediate treatment was designed to treat hazardous fuel ladders and standing fuels, and facilitate the reintroduction of prescribed fire, while decreasing fire-related damage to resources. A description of the intermediate treatment is outlined below.

Cutting
All trees less than 5 inches dbh, except those needed for replacement of lost presettlement trees, would be cut on the intermediate treatment unit. No trees over 5 inches in diameter at breast height (dbh) would be cut on this unit (except where essential for safe prescribed burning). Trees would be thinned with hand tools on the North Rim site and chainsaws on the South Rim site. A higher proportion of white fir, the primary invading species on the experimental block on the North Rim, would be cut. Aspen, a fire susceptible species would not be thinned except for small trees that clearly contribute to a fuel ladder. Oak would only be thinned following the first entry with prescribed fire, rather than thinning concurrently with ponderosa pine. This ensures that surviving, healthy oaks would be selected as replacement trees. Oak thinning would take place only where it is determined to be necessary to achieve treatment objectives.

The following specifications would apply to BOTH the intermediate and minimal treatments.

Treatment of Cut Material
Slash generated by these treatments would be broadcast or pile burned (see page 15 of Appendix C).

Marking
Tree marking requirements have been reduced due to the 5 inch dbh limit on thinned trees. Only leave trees below 5 inches dbh would be marked. All other marking criteria as appropriate would be done as in Alternative "B" (see page 10 above, and page 12 of Appendix C).

Identification of Presettlement Age Trees
See page 10 for identification of presettlement age trees for the intermediate treatment.

Selection of Replacement Trees
See page 10 for selection of replacement trees for the intermediate treatment.

Fireline
See page 10 for firelines around the intermediate treatment unit.

Presettlement Tree Protection
See pages 10-11 for presettlement tree protection for the intermediate treatment.

Stumps
See page 11 for the treatment of stumps on the intermediate treatment unit.

Post-thinning Prescribed Burning
See page 11 for post-thinning prescribed burning on the intermediate treatment unit.

Post-treatment Restoration
See page 11 for post-treatment restoration burning on the intermediate treatment unit.

Post-treatment Monitoring
See page 11 for post-treatment monitoring on the intermediate treatment unit.

II. C.2. MINIMAL TREATMENT

As noted above, one 20-acre unit on both the North and South Rim sites (total of 40 acres) would undergo a minimal treatment. The minimal treatment is designed to treat hazardous fuel ladders and facilitate the reintroduction of prescribed fire, while decreasing fire-related damage to old trees. A description of the minimal treatment is outlined below.

Thinning Prescription
The thinning prescription for Alternative "C" would be the same as Alternative "B" (see page 12), except only trees less than 5 inches would be thinned (see Figure 1, page 16).

Cutting
Only trees that are less than 5 inches dbh and within a set distance of a presettlement or target tree would be cut on the minimal treatment unit (except where essential for safe prescribed burning). The intent of the minimal treatment is: 1) to reduce the threat of prescribed fires moving into the crown of target trees, and 2) to keep the fire intensity of a wildfire low enough to prevent mortality of the target trees. In no case would more trees be thinned under minimal treatment prescription than would have been removed under an intermediate prescription on the same unit. Trees would be thinned with hand tools on the North Rim site and chainsaws on the South Rim site.

Minimal Thinning Stand Cross Section Example - Alternative "C"

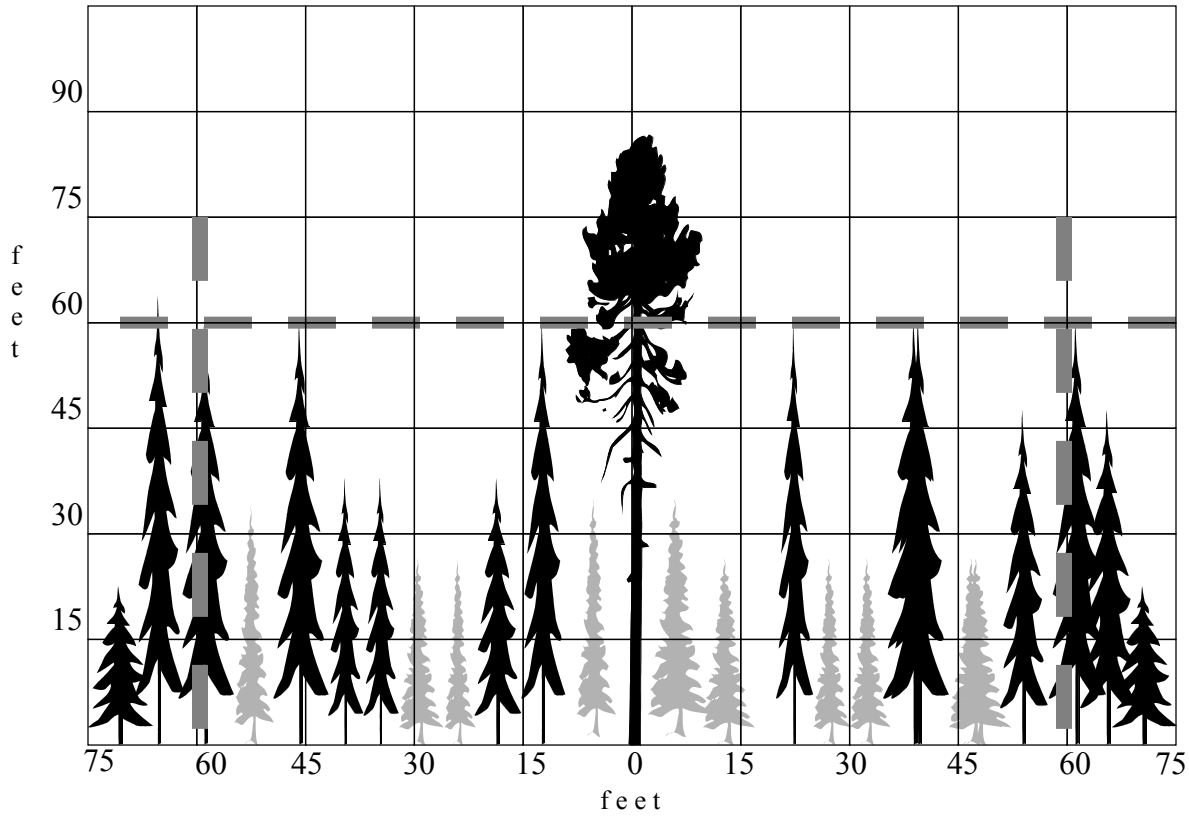


Figure 1. In the minimal treatment detailed in Alternative C, trees 5 inches dbh or greater would be retained (displayed as black trees) around the target tree (depicted as the large tree at "0"). Trees less than 5 inches dbh would be thinned (displayed as gray trees) around the target tree out to a distance equal to the average stand canopy height. The horizontal and vertical dashed gray lines depict the average stand canopy height (60') and maximum thinning distance from the target tree (60'), respectively.

Had the average stand canopy height been 45 feet, the maximum thinning distance would have been 45 feet.

The minimum thinning distance is 40 feet, thus stands with average canopy heights of less than 40 feet would still be thinned out to 40 feet.

Treatment of Cut Material
See page 14 above, and page 15 of Appendix C for treatment of cut material for the minimal treatment.

Marking
See page 14 above and page 10 of Appendix C for marking of the minimal treatment unit.

Identification of Presettlement Age Trees
See page 10 for identification of presettlement age trees for the minimal treatment.

Selection of Replacement Trees
See page 10 for selection of replacement trees for the minimal treatment.

Fireline
See page 10 for firelines around the minimal treatment unit.

Presettlement Tree Protection
See pages 10-11 for presettlement tree protection for the minimal treatment.

Stumps
See page 11 for the treatment of stumps on the minimal treatment unit.

Post-thinning Prescribed Burning
See page 11 for post-thinning prescribed burning on the minimal treatment unit.

Post-treatment Restoration
See page 11 for post-treatment restoration burning on the minimal treatment unit.

Post-treatment Monitoring
See page 11 for post-treatment monitoring on the minimal treatment unit.

II. C.3. BURN-ONLY TREATMENT

As noted above, one 20-acre unit at both the North and South Rim sites (total of 40 acres) would undergo a burn-only treatment. This treatment is broadly intended to represent the current fire management policy at GRCA (USDI National Park Service 1992a). The specific details of the burn treatment would be described in a site-specific burn plan based on the GRCA Fire Monitoring Handbook (sheet 4) Monitoring Type Description Sheets (Appendix A). For safe and effective treatment, burn plans are developed as close to the time of treatment as possible, and are not included in this document. If possible, the burn-only units would be burned at the same time under the same conditions as the other units. Consideration would be given to the fact that there would be lighter ground fuels on these units due to the absence of slash but relatively greater live tree fuels due to the absence of thinning (USDI National Park Service 1992a).

II. C.4. CONTROL

One 20-acre unit on both the North and South Rim research sites (total of 40 acres) would serve as a control and would not receive any treatment. The control unit would be protected from wildfire, prescribed burning, and the effects of thinning. Control unit boundaries would be clearly flagged during thinning operations and the presence and purpose of the control unit would be made clear to thinning operators and prescribed burn planners. No vehicle or equipment use would be permitted within the control units.

The control units would also be protected from the first and subsequent prescribed burning treatments with a secure fireline. Because the need to protect the controls would be long-term, a relatively permanent fireline would be constructed around the control units. Maps of the control unit locations would be provided to GRCA fire managers and other resource managers to ensure their protection from future wildfire, prescribed fire, and other management activities.

II. D. ALTERNATIVES ELIMINATED FROM FURTHER STUDY

Described below are two alternatives that were considered but eliminated from further study.

II. D.1. CONDUCT THIS RESEARCH OUTSIDE OF THE PARK

Park conditions differ substantially from surrounding lands. There are more large, old trees, severe ground and ladder fuels, and few emergency access roads inside the Park. Land use history and management policies also differ from surrounding areas. Since the goal of this research is to test treatments that were designed for GRCA's specific conditions, it is important that the tests be conducted in these areas. Although other land management agencies are also conducting wildfire hazard reduction experiments, their land use practices may change over time. The Park would not be able to ensure that other agencies implement recommended future burn schedules or that they carry out long-term monitoring on lands outside Park boundaries. This could limit the usefulness of the research for Park management and for the scientific community.

II. D.2. CONDUCT THE RESEARCH OUTSIDE OF THE NORTH RIM PROPOSED WILDERNESS

GRCA's North Rim forests have been the subject of at least four agency fire risk assessments since 1989 (Environmental Specialist – 1989; Northwest III Fire Review -1994, Task Force Review – 1994, NPS Fire Program – 1997), all of which have recommended that both fire and mechanical methods be used to reduce hazardous fuel loads. Wildfires that started within the Park have consumed tens of thousands of acres of forest in the Park and on adjoining lands in recent years, including 1,200 acres abutting the proposed experimental treatment site. The areas of North Rim forest with the highest fuel loads are within proposed wilderness (see pages 64-65). The proposed experimental block is located adjacent to, and partially within the non-wilderness Swamp Point road corridor. Other areas entirely outside of the proposed wilderness were also considered during the site evaluation process, but no comparable unburned areas were found within or near developed areas. The proposed treatments would not diminish the area's suitability for possible wilderness designation under NPS criteria.

II. E. ENVIRONMENTALLY-PREFERRED ALTERNATIVE

The Council on Environmental Quality (CEQ) provides direction that the "environmentally preferable alternative is the alternative that will promote the national environmental policy" as expressed in NEPA's Section 101:

1. fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. assure for all generations safe, healthful, productive, and esthetically and culturally pleasing surroundings;
3. attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences;
4. preserve important historic, cultural and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice;
5. achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities; and
6. enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

This agency-preferred alternative would preserve and protect the Park's resources by providing scientifically-based management alternatives and by protecting old-growth ponderosa pine forests for succeeding generations. Grand Canyon's ponderosa pine forests are at risk of severe and dangerous fire. The preferred agency alternative would enable comparisons of management strategies and information gained would be used to: 1) reduce fire risks and preserve safe, healthy, and aesthetically and culturally pleasing surroundings for the long-term; 2) reverse the unintended and undesirable consequences of fire exclusion and begin to restore the structure and functions of the ponderosa community including its biotic and abiotic components; 3) work to

develop a better means to preserve historic, cultural, and natural aspects of Grand Canyon's ponderosa pine forests in a manner that would enable current and future generations of forests a variety of appropriate uses; and 4) provide the benefits offered by wildlands in the Park by managing forests in a sustainable manner.

Alternative "C" would not achieve ecological objectives as quickly or thoroughly as Alternative "B", but would enable development of new forest management strategies in an incremental and adaptive manner. Therefore, the agency-preferred alternative is the environmentally-preferred alternative. Appendix F provides a comparative summary of the alternatives.

III. ENVIRONMENTAL CONSEQUENCES

III. A. NATURAL RESOURCES

III. A.1. AFFECTED ENVIRONMENT

III. A.1.1. AIR QUALITY

Air quality is a critical resource at Grand Canyon. The clarity of the air is essential to visitor enjoyment of scenic vistas and is a sensitive indicator for other air quality concerns. GRCA is a federally designated Class I area under the Clean Air Act. This designation sets the most stringent limits on allowable increases in air pollution. It also sets forth a goal for removing, and preventing any future human-caused haze in the Park.

Since 1959 various state and federal agencies have studied air quality in the Park. Monitoring results have shown that air pollution impairs visibility to some extent 90% of the time. Some of this haze is the result of specific "point sources" of pollution, while much of the haze is regional in nature. Regional haze, as its name implies, comes from many sources spread over a wide area.

The Grand Canyon Visibility Transport Commission (GCVTC) addressed haze at GRCA and 16 other Class I areas on the Colorado Plateau. The Commission's 1996 recommendations include strategies for dealing with point, area, and mobile pollution sources, wildland fire, international pollution transport, and other issues. As part of the GCVTC process, an inventory of in-Park pollution sources was conducted. The inventory found mobile sources (vehicles and their associated road dust) to be the largest regular contributors to in-Park air pollution.

Although the total contribution from all in-Park pollution sources to haze in GRCA was not determined, it was believed to be quite small. The one exception to this is smoke from wildland fire, including both wildfire and management fire. Smoke impacts on visibility in GRCA also depend on weather conditions. Certain climatic conditions cause smoke to flow into the Canyon and become "trapped," rather than rising and dispersing.

While this smoke may be considered a "natural byproduct" of ecosystem processes, its production is under human control, as prescribed burning can be done under conditions that reduce smoke impacts. Fire management personnel have developed and used sophisticated fuel and meteorological models to predict smoke generation and behavior. Managers use these models to minimize smoke impacts on visibility in GRCA and other sensitive airsheds and to maximize smoke plume rise and dispersion. GRCA would utilize techniques that minimize smoke production when conducting the prescribed burning. The Park would initiate burning only after securing a permit from the Arizona Department of Environmental Quality. Issuance of the permit certifies the Department's concurrence that smoke impacts from the permitted fire are expected to be acceptable.

III. A.1.2. BIOTIC COMMUNITIES

SPECIAL STATUS SPECIES

Special Status Wildlife Species
Section 7 consultation with US Fish and Wildlife Service (USFWS) has been initiated for the Mexican spotted owl and the California condor. A separate Biological Assessment has been written for these two species.

Mexican Spotted Owl. The Mexican spotted owl (*Strix occidentalis lucida*) is a federally listed threatened species. This species nests and roosts primarily in closed canopy forests or rocky canyons. In the northern portion of its range, Mexican spotted owl (MSO) nests are located in caves or on cliff ledges in steep-walled canyons. In areas where nesting commonly occurs in trees, Douglas-fir is the most common species used (USDI U.S. Fish and Wildlife Service 1995). South of the Colorado River, MSO most often use conifer species for nesting, although they also use oak for nesting. Nevertheless, recent research has shown that narrow, cool, shaded canyons support most of the nesting activity of MSOs on the Colorado Plateau (USDI U.S. Fish and Wildlife Service 1995).

Critical habitat has recently been designated for the MSO (Federal Register 2/01/01). The North Rim experimental block lies within the area designated as critical habitat and contains the primary constituent elements required to qualify as critical habitat. The Grandview experimental block lies outside the critical habitat boundary. The North Rim block meets the definition of Restricted Habitat as defined in the MSO Recovery Plan (USDI U.S. Fish and Wildlife Service 1995). According to the Recovery Plan:

> *Management priority should be placed on reducing identified risks to spotted owl habitat. The primary existing threat is catastrophic wildfire. Thus, we strongly encourage the use of prescribed and prescribed natural fire to reduce hazardous fuel accumulations. Thinning from below may be desirable or necessary before burning to reduce ladder fuels and the risk of crown fire. Such thinning must emphasize irregular tree spacing (page 94).*

No MSO nests have been found on GRCA, BLM, or USFS administered lands north of the Colorado River in Arizona. However, call surveys have elicited vocal responses from roosting spotted owls in GRCA. In 1992, a male spotted owl responded to calls in the Sinking Ship area which is approximately three miles from the Grandview treatment area on the South Rim (Willey and Van Riper 1992). In that same year, a second spotted owl was heard near the confluence of Dragon and Milk Creek Canyons approximately ten miles from the North Rim treatment area. Neither of these roosting owls was located on lengthy follow-up visits, consequently they can not be accorded “resident single status” as determined by the Inventory Protocol for MSOs (USDA US Forest Service 1991).

In 1991, approximately 6,000 acres of potential North Rim habitat east of the treatment area was surveyed, but no responses were recorded. Surveys were conducted on the North Rim experimental block and surrounding area in spring and summer of 1998 and 1999 using the approved protocol (USDA US Forest Service 1991); no MSO responses were elicited (USGS, Biological Resources Division 2000). In 1994 and 1995, the South Rim treatment area and the surrounding Forest Service and GRCA land were surveyed for spotted owls with negative results. Lastly, surveys were conducted on both blocks in the 2001 season with negative results. Additional surveys will be completed in 2002 prior to implementation of thinning or burning operations.

California Condor. The California condor (CACO) was listed as an endangered species in March 1967 and remains classified as endangered today. In 1996, the USFWS established a nonessential, experimental population of CACOs in Northern Arizona. By declaring the population “experimental, nonessential”, the US FWS can treat this population as “threatened” and develop regulations for management of the population that are less restrictive than mandatory prohibitions covering endangered species. This facilitates efforts to return the CACO to the wild by providing increased opportunities to minimize conflict between the management of

the CACOs with other activities. Within GRCA, the CACO has the full protection of a threatened species (NPS 1991).

Nesting habitat for CACOs includes various types of rock formations such as crevices, overhung ledges, and potholes. CACO foraging typically occurs in open terrain, although recent records are indicating that foraging is occurring in close proximity to clusters of trees. Typical foraging behavior includes long-distance reconnaissance flights, lengthy circling flights over a carcass and hours of waiting at a roost or on the ground near a carcass. Roost sites include cliffs and tall trees, including dead trees (USDI US Fish and Wildlife Service 1996).

All of the experimental, nonessential population of CACOs in Northern Arizona is fitted with radio transmitters allowing field biologists to monitor their movements. Over the past several years, the condors were observed as far west as the Virgin Mountains near Mesquite, Nevada; south to the San Francisco peaks outside of Flagstaff, Arizona; north to Zion and Bryce Canyon National Parks and beyond to Minersville, Utah; and east to Mesa Verde, Colorado and the Four Corners region (Peregrine Fund 2002). Monitoring data indicate condors are using habitat throughout GRCA, with concentration areas in Marble Canyon and the South Rim from Desert View to Hermits Rest.

Northern Goshawk. Northern Goshawk (*Accipiter gentilis*) is a Species of Special Concern to the Arizona Game and Fish Department. Reynolds et al. (1995) reports that specific management prescriptions for Southwestern ponderosa pine designed to improve predator and prey habitats should:

1. increase the abundance of old tree and forests, large snags, and large, downed logs;
2. restore the grouped nature of trees and the interspersion of small patches of different age classes;
3. restore the habitats and foods provided by a well-developed grass, forb, and shrub layer in understories;
4. protect habitats from destructive loss from fire and insect epidemics by reducing fuel ladders and high tree densities.

No known Northern goshawk nests are located within either the North Rim or South Rim experimental blocks. In August 1997, broadcast call surveys were conducted at the North Rim treatment area detected no new nests and no vocal responses were elicited. In 2001, both experimental blocks were surveyed for goshawks; none were found. There are however, two historic but recently unoccupied nest sites located within one-half mile of the burn-only treatment unit of the North Rim experimental block. No Post-fledgling Family Areas (PFAs), as described in the "Management Recommendations for the Northern goshawk in the Southwest" (MRNG) (USDA US Forest Service 1992), have been designated for these territories, but a one-half mile radius around each nest site is managed as a PFA in accordance with MRNG guidelines.

Bat Species. Bat surveys have been conducted in similar habitat close to the experimental blocks. During the period July 24 to July 28, 1995, bats were mist netted over eight stock tanks on USFS land (USFS Kaibab National Forest, Tusayan Ranger District files). These tanks were immediately to south of the Grandview experimental block. Sixteen species and 541 individuals were captured, weighed, aged, sexed, and released. Of the sixteen species encountered, seven are listed as Species of Special Concern by the Arizona Game and Fish Department: long-legged myotis (*Myotis volans*); Townsend's big-eared bat (*Plecotus townsendii*); Allen's lappet-browed bat (*Idionycteris phyllotis*); big free-tailed bat (*Nyctinomops macrotis*); fringed myotis, (*Myotis thysanodes*); Western small-footed myotis (*Myotis ciliolabrum*); and spotted bat (*Euderma maculatum*). Six of the seven Species of Special Concern were captured over stock tanks within 5 miles of the site. At Hull Tank, which lies one-half mile southeast of the study area, five long-legged myotis, three Townsend's big-eared, two Allen's lappet-browed, 14 Western small-footed myotis, and three fringed myotis were captured, measured, and released. At Twin Tanks, one mile south of the area, a long-legged myotis and a fringed myotis were taken. Two big free-tailed bats were captured at McCrae Tank, five miles west of the study area. The single spotted bat taken in the survey was netted at Sand Tank, five miles east of the study area. Although these Species of Special Concern have not been recorded from the study area, the close proximity of the captures, suggest that these species may be present.

The long-legged myotis, Western small-footed myotis, and fringed myotis have been reported to roost in ponderosa pine snags or in damaged live trees. In contrast, the big free-tailed bat, Allen's lappet-browed bat, Townsend's big-eared bat, and the spotted bat prefer cave or rock crevice roost sites.

Special Status Plant Species
There are no known populations of federally listed or species of special concern plants on the experimental units or in the ponderosa pine forest within the boundaries of GRCA. Populations of the endangered sentry milk-vetch (*Astragalus cremnophylax* var. *cremnophylax*) are known from both South and North Rims, but these populations inhabit a narrow strip of limestone within the pinyon-juniper woodland adjacent to the rims of the canyon.

The Kaibab bladderpod (*Lesquerella kaibabensis*), a federally listed species, is not known at this time to occur in GRCA. It is found on limestone soils in subalpine grassland meadows at 8,400-8,800 feet in elevation in the North Kaibab National Forest lands adjacent to the Park. The Grand Canyon rose (*Rosa stellata* ssp. *abyssa*), a species of special concern, is known to occur in GRCA. However, it occurs on limestone soils in the pinyon-juniper and desert scrub communities along the canyon's rims, not in the ponderosa pine type.

There are eleven other known rare plants that occur in the ponderosa pine vegetation community, most of which are thought to occur on the Kaibab Plateau (Brian 2000). In addition to these plants, there are 29 rare species whose habitat is adjacent to the ponderosa pine forest. Four occur in aspen-spruce habitat, six from spruce-fir, one from Douglas-fir, five from mountain brush, two from wet sites, three from disturbed and open areas, seven from meadows, and one from rock or ledge sites.

GENERAL WILDLIFE

Mule Deer and Elk
The North Rim treatment block is located within mule deer (*Odocoileus hemionus*) summer range, while the South Rim treatment block provides both summer and winter habitat to mule deer and elk (*Cervus elaphus*). Elk have only recently been discovered in low numbers on the North Kaibab District of the Kaibab National Forest, but have not been observed on or near the North Rim study area. Whether the South Rim area functions as summer or winter range is dependent upon the amount of snow fall in any given year.

Neither the North Rim nor South Rim treatment blocks serve as fawning or calving areas for these species, but a very large and important elk calving area is located approximately 3 miles southwest of the South Rim site.

Turkey
Both the North Rim and South Rim sites are located in wild turkey (*Meleagris gallopavo*) summer range. The Grandview site, with its abundant Gambel oak, relatively dense herbaceous layer, and nearby drainage slope roosting areas, provides key turkey habitat. The North Rim site lacks the nut-producing species and open grassy areas favored for rearing young, but provides hiding cover. The lack of dependable water sources severely limits the utility of both sites for brood rearing purposes. Neither site appears to provide travel corridor characteristics, but a known, high-use travel corridor to and from Lockett Lake exists two miles southeast of the South Rim site.

Tassel-eared squirrels
Abert squirrels (*Sciurus aberti aberti*) are found on the South Rim site and Kaibab squirrels (*S. a. kaibabensis*) are found on the North Rim site. A recent study by Arizona Game and Fish Department (Dodd et al. 1998) report that mean squirrel fitness was related to tree basal area and mean squirrel recruitment was related to the number of interlocking canopy trees. The dense canopy cover (55.4-61.9%, Covington et al. 1998b) on the North Rim site provides the interlocking canopies that can lead to increased production of the truffle and false-truffle fungal species favored by this species during summer months. The Grandview site supports a relatively high proportion of presettlement trees that provide high-quality habitat for Abert squirrels.

Other Bird Species
A recent Arizona Game and Fish Department study (Rosenstock 1996) provides some indication of overall bird abundance and species richness expected in northern Arizona ponderosa pine and pine/oak habitats. The study included 12 stands of ponderosa pine and 11 stands of pine/oak exhibiting a wide range of habitat conditions resulting from past management practices. The stands were selected from the Coconino National Forest, the North Kaibab District of the Kaibab National Forest, Camp Navajo, and one from the Powell Plateau of GRCA.

These sites are similar to the high-end forest conditions (greater canopy cover, more old-growth trees) found on both the North Rim and South Rim treatment areas. Therefore, the high-end of the population ranges from Rosenstock's data are probably more applicable to the treatment areas. Rosenstock found overall breeding bird abundance ranged from 2.0-4.0 birds per acre across all forest stands. Species richness ranged from 17.0-26.3 species per stand. With regard to species groups, resident and short-term migrants had higher abundance and species richness across stands than neotropical migrants. Resident and short-distance migrant abundance ranged from 1.4-2.8 birds per acre, while neotropical abundance ranged from 0.4-1.3 birds per acre.

GENERAL VEGETATION

Measurements were taken by species and size class to determine forest structure of presettlement reconstruction, current conditions, and projected effects of treatments on the two experimental blocks (Covington et al. 1998b). Presettlement tree density on the South Rim averaged 45.1 trees per acre and basal area averaged 40.4 ft^2/acre. Ponderosa pine comprised approximately one-half to two-thirds of total tree density and Gambel oak forming most of the remainder, with an occasional pinyon or juniper encountered. Ponderosa pine made up 90% of the basal area in the presettlement period.

Presently on the South Rim Grandview site, tree density has increased to an average of 580.0 trees per acre and basal area has increased to 102.4 ft^2/acre. Canopy cover in the contemporary forest ranges from 35-54%, which is higher than more open presettlement conditions. The increased tree density indicates that resources such as light, moisture, and nutrients available to the shrub and herbaceous layers have decreased. It is noteworthy that the Grandview site supports a larger proportion of presettlement trees than other forest research sites in the region.

Snowberry (*Symphoricarpos oreophilus*) and serviceberry (*Amalanchier utahensis*) dominate the South Rim site shrub layer, while the herbaceous layer is largely comprised of mutton grass (*Poa fendleriana*) and squirreltail (*Elymus elymoides*).

Presettlement tree density on the North Rim block averaged 93.1 trees per acre and basal area averaged 100.8 ft^2/ac. Ponderosa pine was the dominant tree species, comprising about two-thirds of the presettlement conifer density and basal area, and on this experimental block ranged from 41-63.7 trees per acre. White fir and Douglas-fir made up the majority of the remaining trees.

Present tree density on the North Rim experimental block averages 571.6 trees per acre and basal area averages 188.6 ft^2/acre. A large number of presettlement trees, particularly ponderosa pine, have died on or near the North Rim block. Species composition has changed from a pine-dominated to a white fir-dominated forest, with the density of white fir exceeding ponderosa pine. Buckbrush (*Ceanothus fendleri*) and sedge (*Carex occidentalis*) dominate the sparse shrub and herbaceous layers of the North Rim site, respectively.

III. A.1.3. SOIL AND WATER

Soils at GRCA are predominantly derived from the Kaibab Limestone Formation with some mixed sedimentary material and aeolian deposits (Hendricks 1985, Brewer et al. 1991). Soils that occur on both the North and South Rims are moderately deep to deep. North Rim soils differ from South Rim soils due to differences in physiography and elevation. North Rim soils are generally deeper, contain more organic matter, and are siltier.

Soils on both experimental blocks have low to moderate erosion potential for the slopes found on the sites. Soil compaction is a concern when these soils are wet. Soil loss levels for these soil types are below tolerance levels of 2.2 tons/acre/year. Soil tolerance is defined as the greatest rate of soil loss that can occur while sustaining inherent soil productivity. Reforestation potential on the South Rim site is moderate given the predominant soil and slope conditions, although this would change to a low rating on shallow soils around bedrock outcrops and on steep slopes. A low to moderate rating alerts resource managers to potential problems for successful revegetation of an area.

Both the North Rim and South Rim study sites are relatively small in size and are easily accessed by existing all-weather roads. Therefore, no additional road building or road improvement projects would be required.

Overall watershed conditions are satisfactory except along unimproved dirt roads where increased runoff is concentrated. The South Rim experimental block falls within the Colorado River watershed on the Coconino Plateau Region (Nations and Stump 1981) near Grandview point. Slopes in the South Rim treatment area range from 0-15%. No perennial streams, regulated flood plains, wetlands, municipal water sources, or fisheries would be affected within or near this study area. Moderately to poorly developed stream channels occur in the area. Surface flow in and around the treatment area is ephemeral and occurs in response to heavy precipitation and spring runoff. Surface flows from the South Rim treatment area flow into Watson Tank and eventually McCrae Tank in Coconino Wash where it is utilized by wildlife and cattle. The remainder of the flow eventually infiltrates to the regional aquifer where it is ultimately discharged via springs and seeps within the Inner Canyon to the Colorado River.

The North Rim experimental block falls within the Colorado River watershed on the Kaibab Plateau. Slopes in the North Rim treatment area range from 0-15%. No perennial streams, regulated flood plains, wetlands, municipal water sources, or fisheries would be affected within the experimental block. Moderately to poorly developed stream channels occur in the area. Surface flow in this treatment area is ephemeral and occurs in response to heavy precipitation and spring runoff. Surface flows from the North Rim experimental block flow into Big Spring Canyon, then Shinumo Creek, a perennial stream, and finally the Colorado River.

III. A.2. METHODOLOGY

All available information on known natural resources was compiled. Where possible, map locations of sensitive resources were compared with locations of the proposed forest management treatments. Predictions about the intensity of effects of the alternatives were based on similar treatments on the Coconino and Kaibab National Forests. The intensity of the effects is articulated as follows:

Negligible: An action that could result in a change to a population or individuals of a species or a natural physical resource, but the change would be so small that it would not be of any measurable or perceptible consequence to the population**.**

Minor: An action that could have a change to a population or individuals of a species or a natural physical resource, but the change would be small and, if it were measurable, it would be a small and localized consequence to the population.

Moderate: An action that would result in some change to a population or individuals of a species or a natural physical resource. The consequence to the population would be measurable but localized.

Major: An action that would have a noticeable change to a population or individuals of a species or a natural physical resource. The change would be measurable and would have a substantial and possible permanent consequence to the population.

Duration of the impacts is defined as follows:

Short-term: impacts that would be less than five years duration

Long-term: impacts that would be five years or more in duration

Cumulative Impacts: The Council on Environmental Quality (CEQ) regulations, which implement the National Environmental Policy Act, require assessment of cumulative impacts in the decision-making process

for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7).

Cumulative impacts were determined by combining the impacts of the proposed alternative with other past, present, and reasonably foreseeable future actions. Therefore it was necessary to attempt to identify other ongoing or reasonably foreseeable future actions within GRCA and, if applicable, the surrounding region. Other forest ecosystem restoration experiments are listed in Appendix G.

III. A.3. REGULATIONS AND POLICIES

National Park Service Organic Act of 1916
(PL Chapter 408, 39 Stat 535 et seq., 16 USC 1)
Through this act, Congress established the NPS and mandated that it "shall promote and regulate the use of the federal areas known as national parks, monuments, and reservations…by such means and measures as to conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of future generations." The Organic Act authorizes the Secretary of the Interior to promulgate rules and regulations necessary for management of the parks. This authority, among others, provides the basis for the regulations in 36 CFR 1.

Clean Air Act
(PL chapter 360, 69 Stat 322m 42 USC et seq.)
The main purpose of this act is to protect and enhance the nation's air quality to promote the public health and welfare. The act establishes specific programs that provide special protection for air resources and air quality related values (AQRVs) associated with NPS units. For example, sections 160-169 of the act establish a program to prevent significant deterioration (PSD) of air quality in clean air regions of the country. The purposes of the PSD program include: 1) to protect resources that might be sensitive to pollutant concentrations lower than the established national standards, and 2) to "preserve, protect and enhance the air quality in national parks, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic or historic value." In section 169A of the act, Congress also established a national goal of remedying any existing and preventing any future manmade visibility impairment in mandatory Class 1 areas.

National Environmental Policy Act of 1969 (NEPA)
(PL 91-190, 42 USC 4321 et seq., 83 Stat 852, 42 USC 4332 as amended)
NEPA is the basic national charter for environmental protections. It contains an "action-forcing" provision to ensure that federal agencies act according to the letter and spirit of the law. Among its provisions, this act declares that it is the policy of the federal government to "preserve important historic, cultural, and natural aspects of our national heritage."

NEPA directs that all practicable means should be used to improve federal functions so that the nation may "…attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences…" Title I of NEPA requires that federal agencies plan and carry out their activities "…so as to protect and enhance the quality of the environment. Such activities shall include those directed to controlling pollution and enhancing the environment." To enact this policy, NEPA requires an interdisciplinary study of the impacts associated with federal programs.

General Authorities Act of 1970
(PL 91-383 sec. 1., 84 Stat 825, 16 USC 1a et seq.)
This act affirmed that all NPS units, including historic sites, recreation areas, etc., while acknowledged to be "distinct in character," were "united through their inter-related purposes and resources into one national park system as cumulative expressions of a single national heritage." The purpose of this act was "to include all

such areas in the system and to clarify the authorities applicable to the system." The act made it clear that the NPS Organic Act and other protective mandates applied equally to all units of the system. Further amendments stated that NPS management of park units should not be conducted "in derogation of the purposes and values for which these various areas have been established."

Federal Water Pollution Control Act (Clean Water Act of 1972)
(PL 92-500, PL 100-433, 86 Stat 816, USC 9 sec.1251 et seq., as amended, 33 USC sec. 1251-1376, and 1987 Federal Water Quality Act)
This act firmly establishes federal regulation of the nation's waters, and contains provisions designed to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The act requires that the states set and enforce water quality standards to meet Environmental Protection Agency (EPA) minimum guidelines. It establishes effluent limitations for point sources of pollution, requires a permit for point source discharge of dredged or fill material, and authorizes a "National Wetlands Inventory." Recent changes brought about by the 1987 Federal Water Quality Act places greater emphasis on toxicological-based criteria and on-site biological monitoring.

Endangered Species Act of 1973
(PL 93-205, 87 Stat 884, 7 USC 136, as amended)
This act requires federal agencies to ensure that their activities (authorized, funded, or carried out) will not jeopardize existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species.

Redwood National Park Act
(PL 95-250, 92 Stat 163, as amended, 1978)
This act amended NPS legislation to direct that within the National Park System, "authorization of activities shall be construed and the protection, management, administration…shall not be exercised in derogation of the values and purposes for which these various areas have been established…" With this additional amendment to NPS law, the NPS is mandated to afford the highest standard of protection and care to park resources; no decision can compromise these resource values, except where specifically authorized by law**.**

Wilderness Act
(PL 88-577, 78 Stat 890, 16 USC 1131 et seq.)
This act established the National Wilderness Preservation System, composed of congressionally designated federally owned areas. Federal agencies are required to administer these areas to provide for their use and enjoyment, now and in the future, and to protect and preserve their wilderness character.

Invasive Species - Executive Order 13112
This executive order requires federal agencies to not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species, unless the agency has determined that the benefits of such actions clearly outweigh the potential harm caused by invasive species. This executive order also requires federal agencies to undertake feasible and prudent measures to minimize risk of harm from invasive species as a result of an agency's actions.

Arizona Revised Statutes R18-2-15 (Environmental Quality – Air Pollution Control)
This statute establishes requirements to: 1) obtain state permits to conduct management-ignited fires, and 2) implement control measures to reduce air pollution from those fires.

Regional Haze Rule
(40 CFR Part 51)
This rule establishes the program goals that tribes and states must follow to return Class I areas to the natural visibility conditions required under the Clean Air Act.

III. A.4. IMPACTS OF ALTERNATIVE "A" ON NATURAL RESOURCES

III. A.4.1. AIR QUALITY

Alternative "A" would have negligible short-term impacts, and minor to moderate long-term impacts on air quality. Vehicle travel in GRCA associated with the NAU research in the area would not occur. Thus short-term and transitory direct impacts to air quality from dust and vehicle emissions would be less. However, Alternative "A" could result in greater indirect impacts to air quality in GRCA and its view-shed than Alternatives "B" and "C". Wildfires could occur on the proposed treatment areas under unfavorable wind/air mixing conditions rather than under the favorable conditions required for ignition of prescribed fires.

Cumulative Air Quality Impacts
Alternative "A" would cause negligible cumulative impacts to air quality.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Implementing this alternative would have no impact on air quality.

III. A.4.2. BIOTIC COMMUNITIES

SPECIAL STATUS SPECIES

Habitat diversity in the ecosystem and associated plant and animal species diversity would not increase. The current trend of the loss of native ecosystems, food webs, flora, and fauna would continue. The prevention of potential future listing of additional species as endangered or threatened, would not be possible. In addition, high intensity wildland fires may produce undesirable loss of habitats, due to the continued build-up of forest fuels. High intensity wildland fires could directly impact special status species utilizing GRCA.

Mexican Spotted Owl
Alternative "A" would have negligible short-term impacts, and minor to moderate long-term impacts on the Mexican spotted owl. Under Alternative "A", the management priority to reduce wildfire threat to spotted owl habitat would not be achieved. Research into methods of reducing wildfire hazards in Southwestern ponderosa pine forests would not occur. The risk of losing Mexican spotted owl habitat in GRCA would continue to increase.

California Condor
Alternative "A" would have negligible impacts on the California condor. Under Alternative "A", there would be no potential for condors to be attracted to the human activity that would occur in the thin and burn activities.

Northern Goshawk
Alternative "A" would have negligible short-term impacts, and minor to moderate long-term impacts on the Northern goshawk. The species' population would be expected to remain stable or decrease in the long-term under this alternative. The preferred habitat of goshawks and their prey, in ponderosa pine ecosystems, is a mosaic of small, widely distributed areas of vegetation with different growth/structural forms. This habitat preference closely resembles the species composition, structure, and landscape pattern in presettlement Southwestern ponderosa pine forests (Reynolds et al. 1995).

Under this alternative, the species composition, structure and landscape pattern of presettlement Southwestern ponderosa pine forests would not be replicated on the experimental blocks. There would be no gain in the habitat preferred by the goshawk and its prey species. Research into methods of reducing wildfire hazards in Southwestern ponderosa pine forests to benefit the goshawk would not occur. The risk of losing portions of goshawk territories near the experimental blocks to high intensity wildfire would continue to increase.

Bat Species
The effects of Alternative "A" on bats would depend on how the site would be managed under future Park fire policy. Tree-roosting bats, all of which use large diameter snags and/or live ponderosa pine, (Hoffmeister 1986) would decrease in the long-term because of the anticipated loss of snags to wildfire, and the loss of large diameter live ponderosa pine from competition with young age class pine and wildfire. Alternative "A" would have negligible short-term impacts, and minor to moderate long-term impacts on special status bat species. However, wildland fire at GRCA can burn from low to moderate to high intensity, depending on the time of year the lightning strikes are successful in igniting burns. Moderate intensity fire, in those stands, has the potential to create complex habitat structure, including consuming some snags and downed logs but also creating new snags. Alternative "A" might have a short- to long-term benefit to these bat species because of the creation of roosting snags.

Bat species that utilize open areas to forage for insects would be adversely impacted under Alternative "A". Under this alternative, additional open foraging areas that would support a diversity of vegetation and insects would not be created. Instead, the forest would be expected to continue to become denser with increased encroachment of pine into previously open meadow areas.

GENERAL WILDLIFE

The effects of Alternative "A" on general wildlife could range from negligible short-term impacts and minor to moderate long-term impacts, to negligible to moderate benefits, depending on how the site would be managed under future Park fire policy. Direct impacts associated with implementation of treatments, such as short-term displacement and limited mortality to small mammals, birds, and reptiles, would not occur under Alternative "A". The risk of losing wildlife habitat to high intensity wildfire would continue to increase.

Mule Deer and Elk
Alternative "A" would have negligible short-term impacts, and minor to moderate long-term impacts on mule deer and elk. There would be no short-term displacement of mule deer and elk from the project site. Thinning dense stands of small-diameter trees to open canopy cover that would initially favor grass and browse species preferred by elk would not occur. There would be no improvement in deer and elk forage production from approximately 500 pounds per acre to approximately 1500 pounds per acre at the Grandview site (Brewer et al. 1991). The elk calving area southwest of the Grandview experimental block would not be disturbed. There would no decrease in the cover value of the experimental block.

Turkey
Alternative "A" would have negligible short-term impacts, and minor to moderate long-term impacts on turkeys. Under Alternative "A" there would be no loss of turkey roost sites. There would be minor impacts on turkey food sources. Acorn, juniper berry, and pinyon nut production would be maintained over the short term under this alternative. There would be no increase in insect abundance associated with the treatments that benefit turkeys.

Tassel-eared Squirrels
Alternative "A" would have negligible short-term impacts, and minor to moderate long-term positive impacts on tassel-eared squirrels. High basal area and interlocking canopy of ponderosa pine favored by tassel-eared squirrels would be maintained and would be expected to increase under Alternative "A". The production of mycorrhizal fungi utilized as food by this species, which is optimal when canopy cover exceeds 60%, would remain stable. The risk of wildfire damage to large areas of tassel-eared squirrel habitat would not be reduced.

Other Bird Species
Alternative "A" would have negligible short-term impacts, and minor to moderate long-term impacts on birds. Bird species that require dense forest habitat would remain at stable levels or possibly increase. Species that depend upon herbaceous and/or shrub layers and associated food webs would stay at stable levels and not increase. Three contributing factors to high bird numbers per unit area (i.e., increased habitat diversity, patchiness, and vegetative layering) would remain the same. Downward trends in habitat diversity and patchiness are anticipated as ponderosa pine stands become denser and invade remnant meadow openings.

GENERAL VEGETATION

Alternative "A" would have negligible short-term impacts, and minor to moderate long-term impacts on vegetation. Trees would not be cut under Alternative "A". Threat to vegetation from a destructive wildfire would continue to increase. Scientific evaluation of the proposed forest management methodologies would not occur.

Slash from thinning would not be generated under Alternative "A", eliminating a potential area for colonization by bark beetles (*Ips* spp.)(Jill Wilson, USDA, USFS, Rocky Mt. Research Station, Flagstaff, AZ, pers. comm., 1998). However, bark beetles are also known to attack weakened trees. Dense forest conditions, that are known to stress or weaken mature trees due to competition with dense stands of younger age trees, would remain under Alternative "A". Old-growth and mature trees existing in a stressed state could provide an avenue for bark beetle colonization and potential outbreak.

Indirect impacts to vegetation of Alternative "A" are numerous. Ponderosa pine on the experimental blocks would not regenerate under the natural conditions described in the affected environment section above. Small diameter trees would continue to become established throughout forested areas in higher frequency than would be expected under natural conditions. Young age class pine and/or fir would continue to proliferate, compete with, and accelerate the mortality of old-growth ponderosa. Increasing numbers of old-growth trees would succumb to disease, insects, or drought, because of crowding and competition from the dense stands of younger trees. Overall tree vigor would be diminished and closed canopy conditions and forest floor litter accumulations would decrease the native shrub and herbaceous plant diversity. Encroachment of pine into remnant meadows and open areas would continue.

CUMULATIVE BIOTIC IMPACTS

Special Status Species
Alternative "A" would cause minor to moderate cumulative impacts on special status species.

General Wildlife
Alternative "A" would have negligible cumulative impacts on wildlife resources.

General Vegetation
Alternative "A" would have negligible cumulative impacts on vegetation. However, research into methods to reduce wildfire hazards in ponderosa pine forests would not occur.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Implementing Alternative "A" (no action) would have no impact on biotic communities.

III. A.4 3. SOIL AND WATER

Alternative "A" would have negligible short-term impacts, and minor to moderate long-term impacts on soil and water. Under this alternative, higher intensity wildland fire would be more likely to occur, increasing soil loss through erosion and soil sterilization. If reduction in forest floor litter does not occur, water cycling in the ponderosa pine ecosystem would not be improved. Ground water supplies and spring flows would not increase while transpiration rates would remain high.

Cumulative Soil and Water Impacts
Alternative "A" would have negligible cumulative impacts on soil and water resources.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Implementing Alternative "A" would have no impact on soil and water resources.

III. A.5. IMPACTS OF ALTERNATIVE "B" ON NATURAL RESOURCES

III. A.5.1. AIR QUALITY

Smoke
Alternative "B" would cause moderate short-term impacts and negligible long-term benefits on air quality. Overall, the acreage burned in the experimental blocks would be smaller than other management fires conducted at GRCA. Depending on the amount of slash/fuel left on the test blocks, fuel per acre may be substantially higher than that encountered in similarly forested stands. Short-term air quality impacts from the research would range from minor to moderate, depending on the dispersion characteristics on the day prescribed burning is conducted.

Smoke mitigation techniques used on other management fires would be applied to this project. The techniques include assuring proper fuel moisture and taking advantage of weather conditions that promote smoke dispersal. Broadcast or slash pile burning would be used to dispose of slash generated by Alternative "B". The amount of pollutants released is dependent on the type of burning. In the Pacific Northwest, burning ponderosa pine slash produces 13 grams of $PM_{2.5}$ (airborne particles with a diameter <2.5 millionths of a meter) per kilogram of fuel, while burning piled slash produces 4 grams/kilogram (USDA US Forest Service 1995). However, the intense heat generated by burning piles damages underlying soils by creating "sterile spots" that would require revegetation. If this experiment should lead to large-scale treatments within the Park, more comprehensive consideration would be given to slash disposal alternatives to burning. Since $PM_{2.5}$ is responsible for nearly all of the haze present in Grand Canyon, reducing its production would reduce visibility impact of forest management projects.

Vehicles
Alternative "B" would cause a minor increase in vehicular emissions. There would be increased traffic on dirt roads, causing increased dispersed dust. The amount produced would be dependent on the types of vehicles used, or number of wheels, the intensity of use (vehicles per day), and precipitation (days with >0.01 inches of precipitation). Most road dust particles are coarse and settle out close to the roadway.
Direct emissions are also factors in air quality. However, the scale of the test study suggests increases in vehicular traffic would be negligible in comparison to total Park traffic. The total vehicle miles traveled in the Park during 1993 were almost 65 million miles. Although complete data are not available, it appears 1997

levels were about 1% higher than 1993 levels. If this experiment were to lead to large-scale treatments within the Park, more comprehensive consideration would be given to vehicle emission mitigation alternatives.

Given the scale of the test project in both time and space, increases in vehicle emissions and road dust should be minor and temporary. Therefore, no mitigation treatments would be used for this research proposal.

Cumulative Air Quality Effects
Cumulative environmental effects of ponderosa pine management in the Southwest United States cannot yet be defined with precision. Few projects have been started to date and those that have are small and geographically separated. Appendix G summarizes thirteen planned and ongoing projects, on city, state, and federal lands managed by at least three federal departments (Interior, Agriculture, and Defense). These land units are currently managed under different laws, as well as different resource, economic and recreational use policies. Treatment prescriptions also differ widely among sites, ranging from continued fire suppression to substantial thinning, hand tools to heavy equipment, with or without prescribed fire. In general, the cumulative effects of regional forest management projects would approximate the combined effects of the individual projects. By this, we mean that projects currently underway are too small and widely dispersed for quantifiable synergistic effects.

Alternative "B" would cause negligible cumulative impacts to air quality.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "B" would result in a short-term moderate adverse impact to air quality due to increased smoke production from prescribed fires and increased vehicle traffic during implementation of this alternative. Mitigation measures associated with this alternative should minimize the impacts to air quality. Alternative "B" would have negligible long-term impacts on air quality.

III. A.5.2. BIOTIC COMMUNITIES

SPECIAL STATUS SPECIES

Mexican Spotted Owl
Alternative "B" would have minor to moderate short-term impacts, and negligible long-term impacts on the Mexican spotted owl. In the unlikely event that nesting owls are located, the area would be considered Protected Habitat. This would require that the more stringent Recovery Plan guidelines for this type of habitat be applied in order to ensure that the proposed action has negligible adverse effect on this species or its critical habitat. Section 7 Consultation with USFWS would be completed prior to implementation of the project. Protected and Restricted Habitat for MSO (as defined in the Mexican spotted owl Recovery Plan) was recently delineated within GRCA. The North Rim experimental block lies within Restricted Habitat. See reference to the Recovery Plan on page 20.

Alternative "B" would be a step toward implementing the management priority to reduce risks to spotted owl habitat on 80-acres of the experimental blocks. The Recovery Plan also requires protection of large trees (>24 inches dbh) and snags. These guidelines are followed under Alternative "B".

California Condor
Alternative "B" would have minor to moderate short-term impacts, and negligible long-term impacts on the California condor. CACOs are naturally curious and it is not uncommon for them to be seen frequenting areas of high human activity, such as Grand Canyon Village on the South Rim. The noise and activity associated with treatment may attract CACOs and can increase the potential for interaction between CACOs and humans on the South Rim experimental block. CACO contact with humans would be of concern if workers harass the birds or if the birds become habituated to humans. Mitigation measures to educate workers of CACO concerns and to cease activities if CACOs are present would reduce potential disturbance from treatment activities on the birds. Hazing by permitted park employees or Peregrine Fund personnel would ensure CACOs do not become habituated to humans. The disturbance would be relatively small and would only require the presence of several workers with chainsaws at any one time, resulting in some human presence for several weeks.

Northern Goshawk
Alternative "B" would have minor to moderate short-term impacts, and negligible long-term impacts on Northern goshawk. The species' population would be expected to remain stable in the long term under this alternative. The preferred habitat of goshawks and their prey, in ponderosa pine, is a mosaic of small, widely distributed areas of vegetation with different growth/structural forms. This habitat preference closely resembles the species composition, structure, and landscape pattern in presettlement Southwestern ponderosa pine forests (Reynolds et al. 1995). As forest conditions today move drastically away from historic conditions, Northern goshawk habitat is degraded.

Implementation of Alternative "B" would improve 80 acres of goshawk habitat. Under this alternative, the species composition, structure and landscape pattern of presettlement Southwestern ponderosa pine forests would begin to be replicated on the experimental blocks. Research into methods of reducing wildfire hazards in Southwestern ponderosa pine forests beneficial to the goshawk would occur. Portions of goshawk territories near the experimental blocks would be at lower risk of loss to high intensity wildfire.

To protect the existing goshawk territory immediately to the southwest of the burn-only unit of the North Rim experimental block, a Park Wildlife Biologist would determine if the territory is occupied. If the territory were occupied, burning would not be allowed during the nesting and fledging period, estimated to be March 30 to September 30. A Park Wildlife Biologist may modify these dates, based on the nesting cycle of this pair.

Bat Species
The seven bat species listed as Species of Special Concern would be negligibly impacted in the short- and long-term by Alternative "B". All bat species would likely benefit from the expected improvement in diversity of forest structure, as this would most likely result in increased insect abundance.

Thinning and burning operations would cause minor short-term disturbance to bat species roosting on the treatment areas. The long-legged myotis, Western small-footed myotis, and fringed myotis have been reported to roost in ponderosa pine snags or in live damaged trees. These three species would likely utilize the proposed experimental blocks for roosting habitat. Implementation of Alternative "B" would not cause the loss of roosting habitat required by these species because the large diameter, live and dead old-growth trees and snags needed by these species would be preserved on the research blocks. In addition, the old-growth trees and snags would be protected from prescribed fire by removal of forest floor litter from their bases. The removal of forest floor litter prevents cambium scorching and root mortality in live trees and ignition in the case of snags.

Alternative "B" would have negligible impact on the big free-tailed bat, Allen's lappet-browed bat, Townsend's big-eared bat, and the spotted bat. These species prefer cave or rock crevice roost sites. Because this type of habitat is not found on the experimental blocks, these species probably roost in locations far removed from the treatment area near or below the Canyon rim.

GENERAL WILDLIFE

Minor mortality of small mammals and reptiles would occur during fuels reduction treatments, including prescribed fire, the removal of trees, and associated surface disturbance. This impact, however, would be ecologically insignificant.

Alternative "B" would have negligible to moderate impacts on wildlife species that prefer dense ponderosa pine forest. Although minor reductions of some species that are dependent upon dense forest conditions may occur, these species would not be eliminated by the implementation of the proposed action. The areas that are subjected to treatments as well as the untreated dense forest surrounding the treated areas would continue to meet the habitat needs of species dependent upon dense forest.

In any case, the existing closed canopy, dense ponderosa forest found in GRCA does not represent natural, sustainable, healthy or diverse conditions for this ecosystem. Rather, it represents an altered condition maintained by human intervention in the form of fire suppression. Destructive crown fires in dense ponderosa forests often result in total habitat loss, watershed degradation, and significant human and economic costs. The experimental blocks would benefit species that require dense forest by lessening the potential for crown fire and associated habitat destruction in the adjacent dense, untreated forest areas.

Alternative "B" would also have negligible to minor impacts on wildlife species that benefit from a variety of vegetation types and/or less dense stands of pine. These species include key predators such as the gray fox (*Urocyon cinereoargenteus*), bobcat (*Lynx rufus*), and ringtail (*Bassariscus astutus*). Alternative "B" would increase wildlife habitat diversity on 80 acres by opening up and releasing dense stands of ponderosa pine and providing suitable growing conditions for native understory grasses, forbs, and shrubs.

Finally, another positive aspect of the project involves the conservation of old-growth trees throughout the treatment area. Alternative "B" helps to ensure that this valuable habitat component for many bird and small mammal species is retained in the ecosystem. In addition, no presettlement-age snags would be cut, so animals using cavities in those snags would not be affected.

Mule Deer and Elk

Alternative "B" would have negligible to minor short- and long-term impacts on mule deer and elk. There would be short-term displacement of mule deer and elk from the project site. There should be no disturbance to the elk calving area southwest of the Grandview site given that this sensitive area is over three miles from the location where thinning and burning would be carried out. Operations would be monitored by a Park Wildlife Biologist to ensure that this is the case. Should deer or elk use be greater than anticipated, timing restrictions would be placed on the project to eliminate disturbance during critical calving periods.

Removal of dense stands of small-diameter trees and opening of the canopy would initially favor grass and browse species on 80 acres of the experimental blocks. It is estimated that under this alternative, the Grandview site would show an improvement in deer and elk forage production from approximately 500 pounds per acre to approximately 1,500 pounds per acre (Brewer et al. 1991, J. Beck, USFS, Kaibab National Forest, pers. comm. 1997).

There would be a decrease in the available cover on the experimental blocks, but adequate cover exists in the immediate area surrounding the 80 acres to be mechanically thinned on the South and North Rim experimental blocks. The burning planned for the experimental blocks would result in an immediate but short-lived release of nutrients that would bring about a "flush" of herbaceous vegetation in the understory. This flush of vegetation would benefit deer and elk. The response of browse species such as cliffrose (*Purshia mexicana*), however, varies with small changes in fire intensity (Blaisdell 1953, Blaisdell and Mueggler 1956, Plummer et al. 1968).

Turkey
Alternative "B" would have minor to moderate short- and long-term impacts on turkeys. Research in Arizona ponderosa pine habitat (Wakeling 1991, Mollohan et al. 1995) indicates that turkey-nesting habitat typically has more ground cover at the nest site than in surrounding areas. In addition, successful nest sites tend to have more cover at the nest site than do unsuccessful nests (Crites 1988). The prescription under Alternative "B" would lead to significantly less accumulation of dead and down woody material on the forest floor on 120 acres of the experimental blocks. The reduction of forest floor woody accumulations would result in a minor loss of nesting habitat in treated areas.

Alternative "B" would not meet Arizona Game and Fish Department (AGFD) recommendations for wild turkey nesting habitat that: 1) at least 20% of an area be made up of 0.1-2 acre areas of cover with 30-60% ground cover at 0-3 feet of height; 2) sites should be multi-storied with >50% overstory cover, the first story $\leq$10 feet above ground level; 3) tree stands should be generally uneven-aged with a predominant size class of 4-12 inches dbh; 4) cover should be made up primarily of large downed logs and scattered or loosely piled slash, deciduous and conifer regeneration, and herbaceous vegetation; and 5) under- and overstory distribution should be generally clumped, with abundant deciduous regeneration.

Under Alternative "B", restoration treatments would reduce the amount of forest that is characterized by >50% canopy cover with the first story $\leq$10 feet above ground level. These forest stand characteristics would only exist in presettlement/replacement tree ponderosa and Gambel oak clumps and combinations thereof. Stands of ponderosa pine with the predominant size class being 4-12 inches dbh would be reduced under this alternative. However, a component of 4-12 inches dbh oak would be retained as replacement trees. Under and overstory distribution of oak, juniper, and ponderosa pine would be clumped, but the clumped distribution of ponderosa pine may not meet requirements which optimize turkey nesting. Ground cover consisting of slash and downed logs would be reduced.

Alternative "B" would also not meet AGFD recommendations for turkey brood habitat that: 1) the brood habitat should have a clumped distribution, with basal areas of 90-120 ft²/ acre; 2) there are small openings (0.5-2 acre) within dense stands and large downed logs are scattered throughout; 3) herbaceous cover tends to be high in the openings (>50% ground cover and 10 inches tall); and 4) approximately 20-50% of the stand should provide feeding habitat and 20-50% should provide resting and escape habitat.

Under Alternative "B", basal area would be less than the 90-120 ft²/acre called for in AGFD recommendations on the full restoration treatment on the Grandview site only. Basal area per clump of presettlement/ replacement ponderosa pine, juniper, and Gambel oak and combinations of the above would meet this requirement, but the entire stand would not exhibit this recommended basal area. Openings between oak and ponderosa pine clumps would be provided through the treatments but may be in excess of the 0.5-2 acres recommended by AGFD. Herbaceous cover in these larger openings should meet AGFD requirements for turkey. Reestablishment of herbaceous cover would occur, with likely increases in production and species diversity, either through natural re-establishment or reseeding efforts. Furthermore, feeding and resting habitat requirements would be met, but escape habitat requirements may be lacking in treated areas.

Tassel-eared Squirrel
Alternative "B" would have minor to moderate short-term impacts and negligible long-term impacts on tassel-eared squirrels. Treatment of ponderosa pine forests would decrease basal area and break up the interlocking canopy of ponderosa found in dense conditions of the experimental blocks. In addition, the availability of fungi needed to support abundant squirrel populations would decrease. Reliable fungi production would only be expected to occur in presettlement/replacement tree clumps.

Other Bird Species
Alternative "B" would have minor to moderate short-term impacts and negligible long-term impacts on other bird species. Bird species dependent upon dense forest cover [e.g., (pygmy nuthatch (*Sitta pygmaea*), violet-green swallow (*Tachycineta thalasina*), cordilleran flycatcher (*Empidonax occidentalis*)] could be impacted

directly through disturbance and habitat loss. In the Park the nuthatch and swallow are common and the cordilleran flycatcher is noted as rarely seen. None of these species are special status species.

In contrast, it is expected that species that show a preference for more open cover [e.g., (chipping sparrow (*Spizella passerina*), Stellar's jay (*Cyanocitta stelleri*)] and species that feed on insects could benefit from implementation of treatments.

Nest sites utilized by sharp-shinned hawks (*Accipiter striatus*) are typically located in young conifer stands (25-50 years old) which have high canopy cover and tree density (Reynolds 1983). Under this alternative, treatments would reduce young tree density and canopy cover, thus potentially reducing the amount of nesting habitat for this species.

Alternative "B" would maintain and invigorate all old-growth trees and reestablish understory herbaceous and shrub species. This would cause beneficial increases in species diversity and habitat diversity. Beneficial habitat structural complexity would also probably be increased on 80 acres of the experimental blocks under Alternative "B".

GENERAL VEGETATION

Alternative "B" would have moderate short- and long-term impacts on vegetation. Direct impacts to vegetation would consist of the removal of most of the postsettlement trees within the full restoration treatment unit. Appendix F and Tables 1-4 in Appendix E list the number of trees to be cut under Alternative "B".

On the Grandview site most trees less than 12 inches dbh would be cut (except for trees needed as replacement trees for dead presettlement trees) on 40 acres of the experimental block. Approximately 4,300 trees (less than 12 inches) would be cut on the full restoration treatment unit and approximately 5,000 trees (less than 12 inches) would be cut on the minimal thinning unit (Tables 1 & 2, Appendix E). (Note: The minimal thinning unit supports more trees than the full restoration unit, resulting in a higher number of trees to be cut.)

On the North Rim full restoration treatment unit, approximately 3,600 trees would be cut. Approximately 3,100 trees would be cut on the North Rim minimal thinning unit. Tables 3 and 4 of Appendix E detail the numbers of trees to be cut by species and size class. Although Table 3D in Appendix E indicates that on the North Rim site approximately 10 Douglas-fir in the 16.0-19.9-inch class would be cut, a determination has been made that these trees could be left without compromising the scientific integrity of the study. This change is also reflected in Appendix F.

Thinned trees would be removed to prevent undesirable fire effects and to allow understory plants to regenerate. No commercial use of the material would be made. Larger material (fuelwood size of 5-12 inches dbh) would be cut and moved to storage locations on each rim, and then transferred to the BIA to be distributed for use as firewood by local Native American communities. Approximately 300 trees on the North Rim treatment area and 1,900 trees on the South Rim treatment area would be transferred to the BIA. After two years, any remaining slash on the storage locations would be burned.

Slash generated by the full restoration and minimal thinning treatments would be broadcast burned. Slash would be lopped into 2-4 foot lengths to ensure rapid drying and facilitate subsequent burning. Slash would be distributed in a manner that protects presettlement trees and residual vegetation to the greatest degree possible given the existing fuel loads. Slash would then be burned in a timely manner to avoid infestation by diseases, insects, or other pathogens.

Some direct impacts to snags of all species (primarily ponderosa pine and Gambel oak) and ages are expected to occur as well. Although all presettlement-age snags within the areas of the two thinning treatments would have forest floor litter raked away from them prior to initiation of prescribed fire, unsound snags are known to ignite from wind borne embers. Attempts would be made to suppress all fires in snags, however the loss of some snags would occur.

Long-term effects to vegetation include increased native vegetation species diversity and density in all areas treated with the fuels reduction prescription. In addition, the risk of stand-replacing wildfires in the ponderosa pine ecosystem within GRCA would be lessened. Areas restored to more natural conditions through thinning and burning would be sustainable for future generations. Low intensity ground fires to which this ecosystem has adapted would again play their natural role.

Additional indirect impacts may occur to postsettlement replacement trees from wind. Opening the forest stand by removal of a majority of stems may make the remaining trees vulnerable to wind damage. Tree mortality from wind damage would be monitored to determine if the marking prescription would need to be modified to include a greater ratio of postsettlement replacement trees in future treatments.

All changes in vegetation density and diversity would be monitored on vegetation and fuel monitoring plots. There are 20 plots per unit and they were established by NAU.

Ponderosa Pine

Alternative "B" would have moderate short- and long-term impacts on ponderosa pine. On the Grandview site approximately 2,700 ponderosas (less than 12 inches dbh) would be cut on the full restoration treatment unit (Table 1A, Appendix E). Approximately 1,800 ponderosas (less than 12 inches dbh) would be cut on the minimal thinning unit (Table 2A, Appendix E).

On the North Rim site, approximately 70 ponderosa pines (less than 5 inches dbh) would be cut on the full restoration treatment unit (Table 3A, Appendix E). Approximately 140 ponderosas (less than 5 inches dbh) would be cut on the minimal thinning unit (Table 4A, Appendix E). (Note: The North Rim minimal thinning unit supports more trees than the full restoration treatment unit, resulting in a higher number of trees to be cut.)

This alternative would cause an approximately 50 year age gap in ponderosa pine age classes on the full restoration treatment units. However, a mosaic of uneven age classes would be retained as old-growth trees and replacements. Regeneration is expected to occur in microsites with mineral soil seedbeds that exclude future ground fire and remove seedling competition with grasses. Deterioration and burning of large diameter ponderosa pine snags and windfalls usually produce these mineral soil seedbed microsites.

Moderate indirect effects on ponderosa pine, both beneficial and deleterious, are expected to occur from the use of prescribed fire as part of the fuels reduction treatments. Prescribed fire in ponderosa pine stands can release substantial amounts of nutrients bound up in surface organic matter. Fire accelerates nutrient cycling mainly by mineralizing nutrients, whereas fire exclusion inhibits this process (Rapport and Yazvenko 1995). Often, there is a net post-burn loss of total nitrogen from the forest floor, but a simultaneous post-burn increase in available soil inorganic nitrogen is often reported. These post-burn nitrogen surges generally benefit tree growth.

Prescribed fire can also cause ponderosa pine mortality due to crown scorch, bole damage and bud scorching. Crown mortality or damage is widely regarded to be the principle cause of pine mortality following fire. Some overstory mortality from prescribed burning is expected, but the prescription would be written to reduce that expected mortality to levels acceptable to Park management. Use of prescribed fire in mechanically thinned units would be planned to occur in cooler, moister conditions than typically occur with wildfires. Removal of slash from the proximity of leave trees, and less intense fire would serve to make mortality from crown scorch minimal.

Additional impacts to ponderosa pine could occur through bole damage and crown/bud scorching resulting from the use of prescribed fire. Cambial damage is most likely to occur when heat is maintained at the base of a tree. Trees only partially girdled have a good chance of survival. Trees can tolerate basal girdling of less than 25% if crown and root damage are minimal. Damage that occurs more than several feet up on the bole appears to increase post-burn mortality more than similar amount of damage near the base (USDA US Forest Service 1997a). Post-burn mortality associated with cambium scorching would be minimized in mechanically thinned units due to pre-burn raking around all old-growth trees.

However, numerous studies indicate that bud scorching/kill may be a more important factor than crown scorch in determining the survival potential of fire-damaged trees. Buds of interior ponderosa pine are large and protected by heavy bud scales that have lethal temperatures 68^{o}F higher than that of needles. Consequently, extensive scorching of pine foliage sometimes occurs with only light damage to buds and twigs, allowing vigorous trees to maintain shoot growth on defoliated branches. Some trees can sustain scorch damage of up to 90% as long as 50% of the buds and twigs survive. Immature, fast growing trees tend to survive the same proportions of scorch better than older, slow growing trees (USDA US Forest Service 1997a). Again, prescribed fire in mechanically thinned units would occur in cooler, moister conditions than typically occur with wildfires. Removal of slash from the proximity of leave trees, and less intense fire would serve to make mortality from bud scorch minimal.

Slash generated by thinning under this alternative could host bark beetle colonization. Thinning and burning would be timed to minimize the likelihood of bark beetles colonizing the project site and larger diameter wood would be cut to short lengths to speed drying and impede colonization by beetles.

Gambel Oak
Alternative "B" would have minor short- and long-term impacts on Gambel oaks. On the Grandview site approximately 1,500 Gambel oaks (less than 9 inches dbh) would be cut on the full restoration treatment unit (Table 1B, Appendix E). Approximately 3,150 Gambel oaks (less than 5 inches dbh) would be cut on the minimal thinning unit (Table 2B, Appendix E). Thinning of oak would occur after the first entry with prescribed fire. (Note: The minimal thinning unit supports more small diameter trees than the full restoration unit, resulting in a higher number of trees to be cut.) No Gambel oaks are found on the North Rim experimental block.

Minor direct impacts to Gambel oak would occur from prescribed fire. Gambel oak is extremely fire tolerant (USDA US Forest Service 1997a). Only high severity fires would produce enough heat to kill buried rhizomes and lignotubers that support sprouting. Gambel oak is most vulnerable to fire during periods of low carbohydrate storage in roots. Root carbohydrates, the energy source for resprouting, are utilized in the spring for leaf development and later for flowering or additional plant growth. It is believed that frequent use of prescribed fire in summer, causing top-killing of sprouts would suppress growth of oak sprouts and resprouting. Burning in fall months when carbohydrate reserves have been accumulated and plants are dormant may not affect growth and sprouting of this species. Under Alternative "B", all prescribed burns would be conducted in fall, winter or spring months when this species is dormant. If sprouting did occur, and was considered a problem, subsequent prescribed fires could potentially be conducted during summer months to thin oak.

Utah Juniper
Alternative "B" would have minor short- and long-term impacts on Utah junipers. At the Grandview site approximately 40 Utah juniper trees (less than 9 inches dbh) would be cut on the full restoration treatment unit (Table 1C, Appendix E). Ten Utah junipers (less than 5 inches dbh) would be cut on the minimal thinning unit (Table 2C, Appendix E). No Utah junipers are found on the North Rim experimental block.

Minor direct impacts to Utah juniper are expected to occur as a result of the use of prescribed fire under Alternative "B". Utah juniper is generally killed when 60% or more of the tree crown is scorched. Younger, small junipers would be expected to experience significant mortality under this alternative. Negligible mortality is expected to the older, mature junipers left under the prescriptions of this alternative. Mature junipers with thicker bark and higher foliage would survive the lower intensity post-treatment burns.

Pinyon Pine
Alternative "B" would have minor short- and long-term impacts on pinyon pines. At the Grandview site approximately 20 pinyon pine trees (less than 5 inches dbh) would be cut on the full restoration treatment unit (Table 1D, Appendix E). Approximately 60 pinyon pines (less than 5 inches dbh) would be cut on the minimal thinning unit (Table 2D, Appendix E). (Note: The minimal thinning unit supports more trees than the

full restoration unit, resulting in a higher number of trees to be cut.) No pinyon pines are found on the North Rim experimental block.

Minor direct impacts to pinyon pine are also expected to occur as a result of the use of prescribed fire. Pinyon pine is generally very susceptible to fire mortality. Tree mortality is directly related to the size and spacing of trees and the extent of understory grasses and shrubs present in the stand. Small pinyon, less than four feet in height are very susceptible to fire.

White Fir
Alternative "B" would have minor short- and long-term impacts on white fir. On the North Rim site approximately 2,550 white fir (less than 9 inches dbh) would be cut on the full restoration unit (Table 3B, Appendix E). Approximately 2,550 white firs (less than 12 inches dbh) would also be cut on the minimal thinning unit (Table 4B, Appendix E). No white firs are found on the South Rim experimental block.

Douglas-Fir
Alternative "B" would have minor short- and long-term impacts on Douglas-fir. On the North Rim site approximately 960 Douglas-fir trees (less than 16 inches dbh) would be cut on the full restoration treatment unit (Table 3D, Appendix E). Approximately 400 Douglas-firs (less than 12 inches dbh) would be cut on the minimal thinning unit (Table 4D, Appendix E). No Douglas-firs are found on the South Rim experimental blocks.

Non-native species
Minor to moderate direct impacts to vegetation due to "disturbance invader species" and exotic species may occur on 120 acres of the experimental blocks. Burning at the Fort Valley and Long Valley Experimental Forests near Flagstaff, Arizona has resulted in substantial changes to the understory. Most evident is the abundance of disturbance invader species such as common mullein (*Verbascum thapsis*), toad flax (*Linaria dalmatica*), and thistle (*Circium* spp.). Common mullein and toad flax are dominant on severely burned sites around fire-killed, old-growth trees. Although some animals use these plants, none are considered favorable by wildlife (Sackett et al. 1996). There is potential for disturbance by invader and exotic species to occur in GRCA, however the possibility is not quantifiable at this time. Fire effects monitoring data indicates that these species have rarely, if ever, been encountered on other burned areas within GRCA. Monitoring would be carried out to detect the presence and rate of spread of non-native species. If invasive non-native species are identified, they would be controlled outside the experimental blocks. Control measures may also be implemented on experimental blocks if warranted by potential for spread by particular species. Risks of spread would be determined in part through use of NPS ranking criteria (USDI National Park Service 2001, Appendix H). Mitigation measures include pressure washing of project work vehicles before entering the Park and parking vehicles on existing roads or parking lots. Any areas disturbed by vehicles would be revegetated using adapted native seed and/or plants, and monitoring and follow-up treatment of exotic vegetation would occur for 2-3 years after project is completed. The information gained about exotic plant irruptions on these small experimental blocks would greatly benefit Park management decisions for other areas.

Sagebrush
Alternative "B" would have minor short- and long-term impacts on sagebrush (*Artemisia* spp.). Sagebrush is a common understory shrub at the Grandview site. It is believed that sagebrush may be reduced in the short-term by prescribed fire and there is the potential for long-term reduction as well. This would occur if native grass species return to or increase in areas previously dominated by sagebrush.

Grasses
Alternative "B" would have moderate impacts on understory grass species. One hundred and twenty acres of forest would be thinned, either mechanically or with prescribed fire. This thinning should enhance the growth of all understory species.

Grass species would respond differently to the prescribed fires conducted as part of this alternative (Sackett et al. 1996). Generally, production of grass species associated with the ponderosa pine ecosystem increases

following fire, but this depends upon several factors such as severity of the burn, season of the burn, and overstory characteristics.

Arizona fescue (*Festuca arizonica*) and squirreltail usually show an increase in production one year after a fire, whereas other species may require a longer recovery period. Use of prescribed fire may cause short-term decrease in herbage production of some species, but long-term increases in production and abundance.

CUMULATIVE BIOTIC EFFECTS

Special Status Species
Alternative "B" would cause negligible cumulative impacts on special status species.

General Wildlife
Cumulative impacts could affect wildlife resources as a result of carrying out actions to meet the research objectives. Fuels reduction treatments during breeding, nesting, and brooding seasons could be detrimental to wildlife, especially bird species. Removal of postsettlement trees for the potential, foreseeable two years of this project would disturb nesting species for several months on 80 acres. During that time frame, however, other surface disturbing activities are scheduled within the Park, including construction of bicycle, hiking, and equestrian paths associated with the Greenway project on the South Rim. These projects are spatially removed and not likely to result in significant additional adverse impacts to species dependent on dense forest cover. It is conceivable, however, that a threshold of removing dense forested habitat that would adversely impact these species could be reached if other surface disturbing projects are proposed and implemented.

Positive cumulative effects may occur for species that require open forest conditions, old-growth and/or snags. Such species would include but are not limited to bat species, mule deer, band-tailed pigeon, gray fox, bobcat, and ringtail.

General Vegetation
The effects of this research on vegetation are limited to the study sites. While the information gained from this research would be considered in future Park planning efforts, this research would not be expanded into other areas for the Park without additional environmental compliance.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "B" would result in short-term negligible impacts, to moderate adverse impacts to biotic communities due to the cutting of trees, followed by prescribed burning. Some species dependent on dense forest conditions would lose 120 acres of potential habitat. Other species dependent on open forest conditions would benefit from an increase in 120 acres of potential habitat. Alternative "B" could result in a short-term negative impact from exotic vegetation due to the potential spread of non-native species on the site after thinning and burning are complete. Mitigation measures associated with this alternative should be sufficient to prevent non-native vegetation from becoming a long-term impact to the site.

III. A.5.3. SOIL AND WATER

Alternative "B" would have negligible to minor short-term impacts, and negligible long-term impacts on soil and water resources on 120 acres of the experimental blocks. The reduction in the overstory and the disturbance and removal of the litter associated with treatment activities, would leave treated areas in an unsatisfactory to low satisfactory watershed condition until a grass/forb and litter layer could be reestablished

within 3-5 years. Once the litter layer and ground cover is reestablished, the areas should return to a satisfactory watershed condition.

In any case, federal mandates require protection of long-term soil productivity and water resources through mitigation measures. These measures include standard procedures developed by the Forest Service, and are included as Mitigation Measures in Appendix I and Best Management Practices (BMPs) in Appendix J. These procedures should keep erosion and sedimentation within acceptable limits by minimizing soil disturbance and increased runoff, and should maintain pre-treatment levels of soil productivity and water quality.

The treatments would have some adverse effect on the soil productivity and watershed condition, but by adapting and implementing mitigation measures and BMPs, those impacts would be reduced. The long-term soil productivity would be maintained with 100% of the area in satisfactory condition or better. This would be accomplished by involving GRCA specialists to help designate skid trails, buffer zones, landings, and by limiting equipment use when the soils are wet.

The increased water yield to overall discharge rates in the watershed due to the reduction of basal area and canopy cover is expected to be negligible. There could be an increase of water during intense storms but the amount would also be negligible. The short-term deterioration of the watershed, which would occur with treatment activities, would return to natural conditions as ground cover returns (generally in 3-5 years). Once ground cover was reestablished, the majority of increased water yield would infiltrate into the soils and through the fractured bedrock, and would not increase runoff or sediment loads.

No toxic materials would be introduced into the soils or watershed during the treatments. Accidental spills from refueling saws or machinery would be minimized by refueling on roadbeds where fuel could be contained and any needed cleanup accomplished without difficulty. Compaction and soil displacement impacts increase with the number of times equipment cross an area either with log removal or with mechanical brush piling. Using rubber tires on heavy equipment minimizes this impact.

Slash would be burned on the site. Broadcast burning would cause less impact to soil and water resources than burning concentrated piles of fuels. In either case, localized slash accumulations could burn at a high enough intensity to sterilize the soils by killing soil microorganisms, cause hydrophobic properties, and remove volatile nitrogen. However, these impacts are about 3-10 years. Impacts to soils from fire are difficult, at best, to analyze. Impacts from mechanical treatments followed by fire can be a combination of heat and compaction that leads to some adverse impacts to soil surface crusts and microorganisms. Where burning is conducted to produce a low intensity fire, some changes in soil and water regimes are difficult to detect. If fires are of moderate to high severity, some changes may occur, but would be hard to detect on this small acreage. The changes may be increased by seasonal soil water leading to prolonged seasonal soil creep. There may be more soil mass movement on slopes from removed vegetative cover. Annual water yield can be increased because of the loss of plants that intercept moisture or provide transpiration. These effects are directly proportional to the amount of the landscape that is burned and to the annual precipitation. Long-term effects depend on the amount of various nutrients that may be mobilized by fire, and the ability of other ecosystem “reservoirs” to capture those nutrients before they are lost from the system. Effects depend on whether the system at GRCA has the ability to fix nitrogen from the atmosphere.

All ephemeral stream channels on the treatment blocks would be evaluated on the basis of potential mitigation requirements. Streamside management zones (SMZ) would be established around stream channels that require mitigation. The mitigation requirements would be designed to: 1) protect the natural flow of ephemeral streams, and the geomorphic processes that maintain the channel; 2) provide unobstructed passage of stormflows to reduce the potential for accelerated streambank erosion and soil loss; and 3) minimize sediment and other pollutants from entering the fluvial system in concentrations above natural levels. The width of the SMZ buffer zones would be determined, in part, by stream class and slope of the banks. All SMZs would include a no-machine-entry buffer strip along stream courses and around sinkholes.

A Park Hydrologist would clearly mark the boundaries of SMZs with distinctive flagging. To prevent compaction and surface displacement from occurring, no equipment or vehicles (snowmobiles) would be permitted in the stream or drainage channels, except at designated crossing sites. If sinkholes are encountered, a no-entry 33 foot buffer strip around the outside edge of the feature would protect sinkholes. This would protect the side slopes from accelerated erosion and prevent increased water flow into the sinkholes.

No meadows have been identified within the treatment blocks. However if a meadow were encountered, a similar buffer zone with the same stipulations would be established.

Cumulative Soil and Water Effects
Alternative "B" would have negligible cumulative impacts on soil and water resources.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "B" would result in negligible to minor short-term impacts and negligible long-term impacts to soil and water resources due to the reduction in overstory and the disturbance associated with treatment activities. Mitigation measures to protect long-term soil productivity and water resources associated with this alternative should be sufficient to prevent any long-term impact to soil and water resources.

III. A.6. IMPACTS OF ALTERNATIVE "C" ON NATURAL RESOURCES

III. A.6.1. AIR QUALITY

Smoke
Alternative "C" would have moderate short-term impacts and negligible long-term benefits on air quality. Overall, the acreage burned in the experimental blocks would be smaller than other management fires conducted at GRCA. Depending on the amount of slash/fuel left on the test blocks, fuel per acre may be substantially higher than that encountered in similarly forested stands. Short-term impacts from the research would range from minor to moderate, depending on the dispersion characteristics on the day prescribed burning is conducted.

Smoke mitigation techniques used on other management fires would be applied to this project. The techniques include assuring proper fuel moisture and taking advantage of weather conditions that promote smoke dispersal. Broadcast or slash pile burning would be used to dispose of slash generated by Alternative "C". The amount of pollutants released is dependent on the type of burning. In the Pacific Northwest, burning ponderosa pine slash produces 13 grams of $PM_{2.5}$ per kilogram of fuel, while burning piled slash produces 4 grams/kilogram (USDA US Forest Service 1995). However, the intense heat generated by burning piles does damage underlying soils, creating "sterile spots" that would require revegetation. If this experiment were to lead to large-scale treatments within the Park, more comprehensive consideration would be given to slash disposal alternatives to burning. Since $PM_{2.5}$ is responsible for nearly all of the haze present in Grand Canyon, reducing its production would reduce visibility impact of fuels reduction projects.

Vehicles
Alternative "C" would cause a minor increase in vehicular emissions. There would be increased traffic on dirt roads, causing increased dispersed dust. The amount produced would be dependent on the types of vehicles used (especially number of wheels), the intensity of use (vehicles per day), and precipitation (days with >0.01 inches of precipitation). Most road dust particles are coarse, and settle out close to the roadway.

Direct tailpipe emissions are also factors in air quality. However, the scale of the test study suggests increases in vehicular traffic would be negligible in comparison to total Park traffic. The total vehicle miles traveled in 1993 were almost 65 million miles. Although complete data are not available, it appears 1997 levels were about 1% higher than 1993's. If this experiment were to lead to large-scale treatments within the Park, more comprehensive consideration would be given to vehicle emission mitigation alternatives.

Given the scale of the test project in both time and space, increases in vehicle emissions and road dust would be minor and temporary. Therefore, mitigation treatments would not be needed for this research.

Cumulative Air Quality Effects
Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Seemingly insignificant actions can add up (i.e. more and more of same type of action) or interact (i.e. various actions adding up to cause a new kind of impact) to cause impacts to the environment.

To properly determine cumulative impacts, a Reasonably Foreseeable Future Action (RFFA) analysis as referenced in 40 Code of Federal Regulations 1508.7, should be used. For the purpose of this analysis, it is assumed that all of the treatments outlined in Alternative "C", as described in this document would be initiated.

Alternative "C" would have negligible cumulative impacts on air quality.

Impairment
Because there would be no major, adverse impacts to resources or values, there would be no impairment to the Park's resources or values.

Conclusion
Alternative "C" would result in a short-term moderate impact to air quality due to increased smoke production from prescribed fires and increased vehicle traffic during implementation of this alternative. Mitigation measures associated with this alternative should minimize the impacts to air quality. Alternative "C" would have negligible long-term impacts on air quality.

III. A.6.2. BIOTIC COMMUNITIES

SPECIAL STATUS SPECIES

Mexican Spotted Owl
Alternative "C" would have minor to moderate short-term impacts, and negligible long-term impacts on the Mexican spotted owl. In the unlikely event that nesting owls are located, the area would be considered Protected Habitat. This would require that the more stringent Recovery Plan guidelines for this type of habitat be applied in order to ensure that the proposed action has no adverse effect on this species. Protected and Restricted Habitat for Mexican spotted owl (as defined in the Mexican spotted owl Recovery Plan) was recently delineated within GRCA. The North Rim experimental block lies within Restricted Habitat. See reference to the Recovery Plan on page 20.

Alternative "C" would be a step toward implementing the management priority to reduce risks to spotted owl habitat on 80 acres of the experimental blocks. The Recovery Plan also requires protection of large trees (>24 inches dbh) and snags. These guidelines are followed under Alternative "C".

California Condor
Alternative "C" would have minor to moderate short-term impacts, and negligible long-term impacts on the California condor. CACOs are naturally curious and it is not uncommon for them to be seen frequenting areas of high human activity, such as Grand Canyon Village on the South Rim. The noise and activity associated with treatment may attract CACOs and can increase the potential for interaction between CACOs and humans

on the South Rim experimental block. CACO contact with humans would be of concern if workers harass the birds or if the birds become habituated to humans. Mitigation measures to educate workers of CACO concerns and to cease activities if CACOs are present would reduce potential disturbance from treatment activities on the birds. Hazing by permitted park employees or Peregrine Fund personnel would ensure CACOs do not become habituated to humans. The disturbance would be relatively small and would only require the presence of several workers with chainsaws at any one time, resulting in some human presence for two or three weeks.

Northern Goshawk
Alternative "C" would have minor to moderate short-term impacts, and negligible long-term impacts on Northern goshawk. The species' population would be expected to remain stable in the long term under this alternative. The preferred habitat of goshawks and their prey, in ponderosa pine ecosystem, is a mosaic of small, widely distributed areas of vegetation with different growth/structural forms. This habitat preference closely resembles the species composition, structure, and landscape pattern in presettlement Southwestern ponderosa pine forests (Reynolds et al. 1995). As forest conditions today move drastically away from historic conditions, Northern goshawk habitat is degraded.

Implementation of Alternative "C" would improve 80 acres of goshawk habitat. Under this alternative, the species composition, structure, and landscape pattern of presettlement Southwestern ponderosa pine forests would begin to be replicated on the experimental blocks. There would be a minor gain in the habitat preferred by the goshawk and its prey species. Research into methods of reducing wildfire hazards in Southwestern ponderosa pine forests beneficial to the goshawk would occur. Portions of goshawk territories near the experimental blocks would be at lower risk of loss to high intensity wildfire.

To protect the existing goshawk territory immediately to the southwest of the burn-only unit of the North Rim experimental block, a Park Wildlife Biologist would determine if the territory is occupied. If the territory is occupied, burning would only be allowed outside of the nesting and fledging period (March 30 to September 30). A Park Wildlife Biologist may modify these dates, based on the nesting cycle of this particular pair.

Bat Species
The seven bat species listed as Species of Special Concern would be negligibly impacted in the short- and long-term by Alternative "C". All bat species would likely benefit from the expected improvement in diversity of forest structure, as this would most likely result in increased insect abundance.

Thinning and burning operations would cause minor short-term disturbance to bat species roosting on the treatment areas. The long-legged myotis, Western small-footed myotis, and fringed myotis have been reported to roost in ponderosa pine snags or in live damaged trees. These three species would likely utilize the proposed experimental blocks for roosting habitat. Implementation of Alternative "C" would not cause the loss of roosting habitat required by these species because the large diameter, live and dead old-growth trees and snags needed by these species would be preserved on the research blocks. In addition, the old-growth trees and snags would be protected from prescribed fire by removal of forest floor litter from their bases. The removal of forest floor litter prevents cambium scorching in live trees and ignition in the case of snags.

Alternative "C" would have negligible impact on the big free-tailed bat, Allen's lappet-browed bat, Townsend's big-eared bat, and the spotted bat. These species prefer cave or rock crevice roost sites. Because this type of habitat is not found on the experimental blocks, these species probably roost in locations far removed from the treatment area near or below the Canyon rim.

GENERAL WILDLIFE

Minor mortality of small mammals and reptiles would occur during fuels reduction treatments, including prescribed fire, the removal of trees, and associated surface disturbance. This impact, however, would be ecologically insignificant.

Alternative "C" would have negligible to moderate impacts on wildlife species that prefer dense ponderosa pine forest. Although minor reductions of some species that are dependent upon dense forest conditions may occur, these species would not be eliminated by the implementation of the proposed action. The areas that are subjected to treatments as well as the untreated dense forest surrounding the treated areas would continue to meet the habitat needs of species dependent upon dense forest.

In any case, the existing closed canopy, dense ponderosa forest found in GRCA does not represent natural, sustainable, healthy or diverse conditions for this ecosystem. Rather, it represents an altered condition maintained by human intervention in the form of fire suppression. Destructive crown fires in dense ponderosa forests often result in total habitat loss, watershed degradation, and significant human and economic costs. The experimental blocks would benefit species that require dense forest by lessening the potential for crown fire and associated habitat destruction in the adjacent dense, untreated forest areas.

Alternative "C" would also have negligible to minor impacts on wildlife species that benefit from a variety of vegetation types and/or less dense stands of pine. These species include key predators such as the gray fox, bobcat, and ringtail. Alternative "C" would increase wildlife habitat diversity by opening up and releasing dense stands of ponderosa pine and providing suitable growing conditions for native understory grasses, forbs, and shrubs.

Finally, another positive aspect of the project involves the conservation of old-growth trees throughout the treatment area. Alternative "C" helps to ensure that this valuable habitat component for many bird and small mammal species is retained in the ecosystem. In addition, as all presettlement snags would not be cut, cavity-nesting species would not be affected by implementation of Alternative "C".

Mule Deer and Elk

Alternative "C" would have negligible to minor short- and long-term impacts on mule deer and elk. There would be short-term displacement of mule deer and elk from the project site. There should be no disturbance to the elk calving area southwest of the Grandview site given that this sensitive area is over three miles from the location where thinning and burning would be carried out. Operations would be monitored by the Park Biologist to ensure that this is the case. Should deer or elk use be greater than anticipated, timing restrictions would be placed on the project to eliminate disturbance during critical calving periods.

Removal of dense stands of small-diameter trees and opening of the canopy would initially favor grass and browse species on 80 acres of the experimental blocks. It is estimated that, under this alternative, the Grandview site would show an improvement in deer and elk forage production from approximately 500 pounds per acre to approximately 1,500 pounds per acre (Brewer et al. 1991, J. Beck, USFS, Kaibab National Forest, pers. comm. 1997).

There would be a decrease in the available cover on the experimental blocks, but adequate cover exists in the immediate area surrounding the 80 acres to be mechanically thinned on both the North and South Rim experimental blocks. The burning planned for the experimental blocks would result in an immediate but short-lived release of nutrients that would bring about a "flush" of herbaceous vegetation in the understory. This flush of vegetation would benefit deer and elk. The response of browse species such as cliffrose, however, varies with small changes in fire intensity (Blaisdell 1953, Blaisdell and Mueggler 1956, Plummer et al. 1968).

Turkey

Alternative "C" would have minor to moderate short- and long-term impacts on turkeys. Research in Arizona ponderosa pine habitat (Wakeling 1991, Mollohan et al. 1995) indicates that turkey-nesting habitat typically has more ground cover at the nest site than in surrounding areas. In addition, successful nest sites tend to have more cover at the nest site than do unsuccessful nests (Crites 1988). The prescription under Alternative "C" would lead to significantly less accumulation of dead and down woody material on the forest floor on the area. The reduction of forest floor woody accumulations would result in a minor loss of nesting habitat in treatment areas.

Alternative "C" would not meet AGFD recommendations for wild turkey nesting habitat (see page 34). Under Alternative "C", treatments would reduce the amount of forest that is characterized by >50% canopy cover with the first story ≤10 feet above ground level. These forest stand characteristics would only exist in presettlement/replacement tree ponderosa and Gambel oak clumps and combinations thereof. Stands of ponderosa pine with the predominant size class being 4-2 inches dbh would be reduced under this alternative. However, oaks over 5 inches dbh would not be thinned. Under and overstory distribution of oak, juniper, and ponderosa pine would be clumped, but the clumped distribution of ponderosa pine may not meet requirements which optimize turkey nesting. Ground cover consisting of slash and downed logs would be reduced.

Alternative "C" would also not meet AGFD recommendations for turkey brood habitat (see page 34). Under Alternative "C", basal area could be less than the 90-120 ft^2/acre called for in AGFD recommendations on the intermediate unit on the Grandview site only. Basal area per clump of presettlement/replacement ponderosa pine, juniper, and Gambel oak and combinations of the above would meet this requirement, but the entire stand may not exhibit this recommended basal area. Openings between oak and ponderosa pine clumps would be provided through the treatments but may be in excess of the 0.5-2 acres recommended by AGFD. Herbaceous cover in these larger openings should meet AGFD requirements for turkey. Reestablishment of herbaceous cover would occur, with likely increases in production and species diversity either through natural re-establishment or reseeding efforts. Furthermore, feeding and resting habitat requirements would be met, but escape habitat requirements may be lacking in areas treated under the intermediate prescription.

Tassel-eared Squirrel
Alternative "C" would have minor to moderate short-term impacts and negligible long-term impacts on tassel-eared squirrels. Treatment of ponderosa pine forests would decrease basal area and break up the interlocking canopy of ponderosa found in dense conditions of the experimental blocks. In addition, the availability of fungi needed to support abundant squirrel populations would decrease. Reliable fungi production would only be expected to occur in presettlement/replacement tree clumps.

Other Bird Species
Alternative "C" would have minor to moderate short-term impacts, and negligible long-term impacts on other bird species. Bird species dependent upon dense forest cover (e.g., pygmy nuthatch, violet-green swallow, cordilleran flycatcher) could be impacted directly through disturbance and habitat loss. The nuthatch and swallow are common in the Park, and the cordilleran flycatcher is noted as rarely seen. None of these species are special status species.

In contrast, it is expected that species that show a preference for more open cover (e.g., chipping sparrow, Stellar's jay) and species that feed on insects could benefit from implementation of treatments.

Nest sites utilized by sharp-shinned hawks are typically located in young conifer stands (25-50 years old) which have high canopy cover and tree density (Reynolds 1983). Under this alternative, treatments would reduce small-diameter tree density and canopy cover, thus potentially reducing the amount of nesting habitat for this species.

Alternative "C" would maintain and invigorate old-growth trees and reestablish understory herbaceous and shrub species. This would cause beneficial increases in species diversity and habitat diversity. Beneficial habitat structural complexity would also probably be increased on 80 acres of the experimental blocks under Alternative "C".

GENERAL VEGETATION

Alternative "C" would have moderate short- and long-term impacts on study site vegetation. Direct impacts to vegetation would include cutting of most of the trees less than 5 inches dbh on 40 acres of the experimental units. In the minimal treatment units the trees would only be thinned immediately around the target trees. Appendix F and Tables 5-8 in Appendix E list the number of trees to be cut under Alternative "C".

On the Grandview site approximately 2,400 (less than 5 inches) would be cut on the intermediate treatment unit and approximately 4,360 trees (less than 5 inches) would be cut on the minimal treatment unit (Tables 5 and 6 of Appendix E). (Note: The minimal treatment unit supports more trees than the intermediate unit, resulting in a higher number of trees to be cut.)

On the North Rim intermediate treatment unit, approximately 3,300 trees (less than 5 inches) would be cut. Approximately 2,900 trees (less than 5 inches) would be cut on the North Rim minimal treatment unit. Tables 7 and 8 of Appendix E detail the numbers of trees to be cut by species and size class.

There would be no commercial use of the thinned material. Slash generated by the intermediate and minimal treatments would be broadcast burned. Slash would be lopped into 2 to 4 foot lengths to ensure rapid drying to facilitate subsequent burning. Slash would be distributed in a manner that protects presettlement trees and residual vegetation to the greatest degree possible given existing fuel loads. Slash would then be burned in a timely manner to avoid infestation by diseases, insects, or other pathogens.

Some direct impacts to snags of all species (primarily ponderosa pine and Gambel oak) and ages are expected to occur. Although all presettlement-age snags within the areas of the two thinning treatments would have forest floor litter raked away from them prior to initiation of prescribed fire, unsound snags are known to ignite from wind borne embers. Attempts would be made to suppress all fires in snags, however the loss of some snags would occur. In the long-term, preservation of old live trees would ensure that more trees become large enough to provide suitable wildlife habitat.

Long-term effects to study site vegetation include increased native vegetation species diversity and density in all areas treated with the fuels reduction prescription. In addition, these treatment areas would reduce hazards of wildfire for those locations at greatest risk. Those areas restored to more natural conditions through thinning and burning would be sustainable for future generations.

Additional indirect impacts may occur to postsettlement replacement trees from wind. Opening the forest stand by removal of a majority of stems may make the remaining trees vulnerable to wind damage. Tree mortality from wind damage would be monitored to determine if the marking prescription would need to be modified to include a greater ratio of postsettlement replacement trees in future treatments.

Changes in vegetation density and diversity would be monitored on vegetation and fuels monitoring plots. There are 20 plots per unit and they were established by NAU.

The effects of this research on vegetation are limited to the study sites. While the information gained from this research would be considered in future Park planning efforts, this research would not be expanded into other areas for the Park without additional environmental compliance.

Ponderosa Pine

Alternative "C" would have moderate short- and long-term impacts on ponderosa pine. On the Grandview site approximately 1,150 ponderosas (less than 5 inches dbh) would be cut on the intermediate treatment unit (Table 5A of Appendix E). Approximately 1,150 ponderosas (less than 5 inches dbh) would be cut on the minimal treatment unit (Table 6A of Appendix E). (Note: The minimal treatment unit supports more trees than the intermediate treatment unit, resulting in a higher number of trees to be cut.)

On the North Rim site, approximately 70 ponderosa pines (less than 5 inches dbh) would be cut on the intermediate treatment unit (Table 7A of Appendix E). Approximately 140 ponderosas (less than 5 inches dbh) would be cut on the minimal treatment unit (Table 8A of Appendix E). (Note: The North Rim minimal treatment unit also supports more trees than the intermediate treatment unit, resulting in a higher number of trees to be cut.)

A mosaic of uneven age classes would be retained as old-growth trees and replacements. Representatives of some age classes that have originated in the past 120 years would be reduced in the intermediate treatment unit. Regeneration is expected to occur in microsites with mineral soil seedbeds that exclude future ground

fire and remove seedling competition with grasses. Deterioration and burning of large diameter ponderosa pine snags and windfalls usually produce these mineral soil seedbed microsites.

Indirect moderate effects, both beneficial and deleterious, on ponderosa pine are expected to occur from the use of prescribed fire as part of the treatments. Prescribed fire in ponderosa pine stands can release substantial amounts of nutrients bound up in surface organic matter. Fire accelerates nutrient cycling mainly by mineralizing nutrients, whereas fire exclusion inhibits this process (Rapport and Yazvenko 1995). Often, there is a net post-burn loss of total nitrogen from the forest floor, but a simultaneous post-burn increase in available soil inorganic nitrogen is often reported. These post-burn nitrogen surges generally benefit tree growth.

Prescribed fire can also cause ponderosa pine mortality due to crown scorch, bole damage and bud scorching. Crown mortality or damage is widely regarded to be the principle cause of pine mortality following fire. Some overstory mortality from prescribed burning is expected, but the prescription would be written to reduce that expected mortality to levels acceptable to Park management. Use of prescribed fire in mechanically thinned units would be planned to occur in cooler, moister conditions than typically occur with wildfires. Removal of slash from the proximity of leave trees, and less intense fire would serve to make mortality from crown scorch minimal.

Additional impacts to ponderosa pine could occur through bole damage and crown/bud scorching resulting from the use of prescribed fire. Cambial damage is most likely to occur when heat is maintained at the base of a tree. Trees only partially girdled have a good chance of survival. Trees can tolerate basal girdling of less than 25% if crown and root damage are minimal. Damage that occurs more than several feet up on the bole appears to increase post-burn mortality more than similar amount of damage near the base (USDA US Forest Service 1997a). Post-burn mortality associated with cambium scorching would be minimized in mechanically thinned units due to pre-burn raking around all old-growth trees.

However, numerous studies indicate that bud scorching/kill may be a more important factor than crown scorch in determining the survival potential of fire-damaged trees. Buds of interior ponderosa pine are large and protected by heavy bud scales that have lethal temperatures 68^{o}F higher than that of needles. Consequently, extensive scorching of pine foliage sometimes occurs with only light damage to buds and twigs, allowing vigorous trees to maintain shoot growth on defoliated branches. Some trees can sustain scorch damage of up to 90% as long as 50% of the buds and twigs survive. Immature, fast growing trees tend to survive the same proportions of scorch better than older, slow growing trees (USDA US Forest Service 1997a). Again, prescribed fire in mechanically thinned units would occur in cooler, moister conditions than typically occur with wildfires. Removal of slash from the proximity of leave trees, and less intense fire would serve to make mortality from bud scorch minimal.

Slash generated by thinning under this alternative could host bark beetle colonization. Thinning and burning would be timed to minimize the likelihood of bark beetles colonizing the project site, and slash would be cut to short lengths to speed drying and impede colonization by beetles.

Gambel Oak

Alternative "C" would have minor short- and long-term impacts on Gambel oaks. On the Grandview site approximately 1,200 Gambel oaks (less than 5 inches dbh) would be cut on the intermediate treatment unit (Table 5B of Appendix E). Approximately 3,150 Gambel oaks (less than 5 inches dbh) would be cut on the minimal treatment unit (Table 6B of Appendix E). Thinning of oak would occur after the first entry with prescribed fire. (Note: The minimal treatment unit supports more trees than the intermediate unit, resulting in a higher number of trees to be cut.) No Gambel oaks are found on the North Rim experimental block.

Minor direct impacts to Gambel oak would occur from prescribed fire. Gambel oak is extremely fire tolerant (USDA US Forest Service 1997a). Only high severity fires would produce enough heat to kill buried rhizomes and lignotubers that support sprouting. Gambel oak is most vulnerable to fire during periods of low carbohydrate storage in roots. Root carbohydrates, the energy source for resprouting, are utilized in the spring for leaf development and later for flowering or additional plant growth. It is believed that frequent use of prescribed fire in summer, causing top-killing of sprouts would suppress growth of oak sprouts and resprouting

from rhizomes and lignotubers. Burning in fall months when carbohydrate reserves have been accumulated and plants are dormant may not affect growth and sprouting of this species. Under Alternative "B", all prescribed burns would be conducted in fall, winter or spring months when this species is dormant. If sprouting did occur, and was considered a problem, subsequent prescribed fires could be conducted during summer months to thin oak.

Utah Juniper
Alternative "C" would have minor short- and long-term impacts on Utah junipers. At the Grandview site approximately 20 Utah juniper trees (less than 5 inches dbh) would be cut on the intermediate treatment unit (Table 5C of Appendix E). Ten Utah junipers (less than 5 inches dbh) would be cut on the minimal treatment unit (Table 6C of Appendix E). No Utah junipers are found on the North Rim experimental block.

Minor direct impacts to Utah juniper are expected to occur as a result of the use of prescribed fire under Alternative "B". Utah juniper is generally killed when 60% or more of the tree crown is scorched. Younger, small junipers would be expected to experience significant mortality under this alternative. Negligible mortality is expected to the older, mature junipers left under the prescriptions of this alternative. Mature junipers with thicker bark and higher foliage would survive the lower intensity post-treatment burns.

Pinyon Pine
Alternative "C" would have minor short- and long-term impacts on pinyon pines. At the Grandview site approximately 20 pinyon pine trees (less than 5 inches dbh) would be cut on the intermediate treatment unit (Table 5D of Appendix E). Approximately 60 pinyon pines (less than 5 inches dbh) would be cut on the minimal treatment unit (Table 6D of Appendix E). (Note: The minimal treatment unit supports more trees than the intermediate unit, resulting in a higher number of trees to be cut.) No pinyon pines are found on the North Rim experimental block.

Minor direct impacts to pinyon pine are also expected to occur as a result of the use of prescribed fire. Pinyon pine is generally very susceptible to fire mortality. Tree mortality is directly related to the size of trees and the extent of understory grasses and shrubs present in the stand. Small pinyon, less than four feet in height are very susceptible to fire.

White Fir
Alternative "C" would have minor short- and long-term impacts on white fir. On the North Rim site approximately 2,530 white fir trees (less than 5 inches dbh) would be cut on the intermediate treatment unit (Table 7B of Appendix E). Approximately 2,470 white firs (less than 5 inches dbh) would be cut on the minimal treatment unit (Table 8B of Appendix E). No white firs are found on the South Rim experimental block.

Douglas-Fir
Alternative "C" would have minor short- and long-term impacts on Douglas-fir. On the North Rim site approximately 680 Douglas-fir trees (less than 5 inches dbh) would be cut on the intermediate treatment unit (Table 7D of Appendix E). Approximately 275 Douglas-firs (less than 5 inches dbh) would be cut on the minimal treatment unit (Table 8D of Appendix E). No Douglas-firs are found on the South Rim experimental block.

Non-native species
Minor to moderate direct impacts to vegetation due to "disturbance invader species" and exotic species may occur on 120 acres of the experimental blocks. Burning at the Fort Valley and Long Valley Experimental Forests near Flagstaff, Arizona has resulted in substantial changes to the understory. Most evident is the abundance of disturbance invader species such as common mullein, toad flax, and thistle. Common mullein and toad flax are dominant on severely burned sites around fire-killed, old-growth trees. Although some animals use these plants, none are considered favorable by wildlife (Sackett et al. 1996). There is potential for disturbance by invasive species to occur in GRCA, however the possibility is not quantifiable at this time. Fire effects monitoring data indicates that these species have rarely, if ever, been encountered on other burned areas within GRCA. Monitoring would be carried out to detect the presence and rate of spread of non-native

species. If invasive non-native species are identified, they would be controlled outside the experimental blocks. Control measures may also be implemented for specific species on experimental blocks if warranted by potential for spread. Risks of spread would be determined in part through use of NPS ranking criteria (USDI National Park Service 2001, Appendix H). Mitigation measures are listed on page 38. The information gained about exotic plant irruptions on these small experimental blocks would greatly benefit Park management decisions for other areas.

Sagebrush
Alternative "C" would have minor short- and long-term impacts on sagebrush. Sagebrush is a common understory shrub on the Grandview site. It is believed that sagebrush may be reduced in the short term by prescribed fire and there is the potential for long-term reduction as well. This would occur if native grass species return to or increase in areas previously dominated by sagebrush.

Grasses
Alternative "C" would have moderate impacts on understory grass species. One hundred and twenty acres of forest would be thinned, either mechanically or with prescribed fire. This thinning should enhance the growth of all understory species.

Grass species would respond differently to the prescribed fires conducted as part of this alternative (Sackett et al. 1996). Generally, production of grass species associated with the ponderosa pine ecosystem increases following fire, but this depends upon several factors such as severity of the burn, season of the burn, and overstory characteristics.

Arizona fescue and squirreltail usually show an increase in production one year after a fire, whereas other species may require a longer recovery period. Use of prescribed fire may cause short-term decrease in herbage production of some species, but long-term increases in production and abundance.

CUMULATIVE BIOTIC EFFECTS

Special Status Species
Alternative "C" would cause negligible cumulative impacts on special status species.

General Wildlife
Alternative "C" would have negligible cumulative impacts on wildlife resources. Treatments during breeding, nesting, and brooding seasons could be detrimental to wildlife, especially bird species. Removal of 5 inch or less dbh trees for the potential, foreseeable two years of this project would disturb nesting species for several months on 80 acres. During that time frame, however, other surface disturbing activities are scheduled within the Park, including construction of bicycle, hiking, and equestrian paths associated with the Greenway project on the South Rim. These projects are spatially removed and not likely to result in significant additional adverse impacts to species dependent on dense forest cover. It is conceivable, however, that a threshold of removing dense forested habitat that would adversely impact these species could be reached if other surface disturbing projects are proposed and implemented.

Positive cumulative effects may occur for species that require habitat open forest conditions, old-growth and/or snags. Such species would include but are not limited to bat species, mule deer, band-tailed pigeon, gray fox, bobcat, and ringtail.

General Vegetation
The effects of this research on vegetation are limited to the study sites. While the information gained from this research would be considered in future Park planning efforts, this research would not be expanded into other areas for the Park without additional environmental compliance.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the

natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "C" would result in short-term negligible to moderate adverse impacts to biotic communities due to the cutting of trees less than 5 inches dbh, followed by prescribed burning. Some species dependent on dense forest conditions would lose 120 acres of potential habitat. Other species dependent on open forest conditions would benefit from an increase in 120 acres of potential habitat. Alternative "C" could result in a short-term negative impact from exotic vegetation due to the potential spread of non-native species on to the site after thinning and burning are complete. Mitigation measures associated with this alternative should be sufficient to prevent non-native vegetation from becoming a long-term impact to the site.

III. A.6.3. SOIL AND WATER

Alternative "C" would have negligible to minor short-term impacts, and negligible long-term impacts on soil and water resources on 120 acres of the experimental blocks. The reduction in the overstory and the disturbance and removal of the litter associated with treatment activities, would leave treated areas in an unsatisfactory to low satisfactory watershed condition until a grass/forb and litter layer could be reestablished within 3-5 years. Once the litter layer and ground cover is reestablished, the areas should return to a satisfactory watershed condition.

In any case, federal mandates require protection of long-term soil productivity and water resources through mitigation measures. These measures include standard procedures developed by the Forest Service, and are included as Mitigation Measures in Appendix I and Best Management Practices (BMPs) in Appendix J. These procedures should keep erosion and sedimentation within acceptable limits by minimizing soil disturbance and increased runoff, and should maintain pre-treatment levels of soil productivity and water quality.

The fuels reduction treatments would have some adverse effect on the soil productivity and watershed condition, but by adapting and implementing mitigation measures and BMPs, those impacts would be reduced. The long-term soil productivity would be maintained with 100% of the area in satisfactory condition or better.

Any change to overall discharge rates in the watershed due to the reduction of basal area and canopy cover is expected to be negligible. There could be an increase of water during intense storms but the amount would also be negligible. The short-term deterioration of the watershed, which would occur with treatment activities, would return to natural conditions as ground cover returns (generally in 3-5 years). Once ground cover was reestablished, the majority of increased water yield would infiltrate into the soils and through the fractured bedrock, and would not increase runoff or sediment loads.

No toxic materials would be introduced into the soils or watershed during the treatments. Accidental spills from refueling saws or machinery would be minimized by refueling on roadbeds where fuel could be contained and any needed cleanup accomplished without difficulty.

Slash would be burned on the site. Broadcast burning would cause less impact to soil and water resources than burning concentrated piles of fuels. In either case, localized slash accumulations could burn at a high enough intensity to sterilize the soils by killing soil microorganisms, cause hydrophobic properties, and remove volatile nitrogen. These are temporary to long-term impacts (3-10 years).

All ephemeral stream channels on the treatment blocks would be evaluated on the basis of potential mitigation requirements. Streamside management zones (SMZ) would be established around stream channels that require mitigation. The mitigation requirements would be designed to: 1) protect the natural flow of ephemeral streams, and the geomorphic processes that maintain the channel; 2) provide unobstructed passage of stormflows to reduce the potential for accelerated streambank erosion and soil loss; and 3) minimize sediment and other pollutants from entering the fluvial system in concentrations above natural levels. The width of the

SMZ buffer zones would be determined, in part, by stream class and slope of the banks. All SMZs would include a no-machine-entry buffer strip along stream courses and around sinkholes.

The Park Hydrologist would clearly mark the boundaries of SMZs with distinctive flagging. To prevent compaction and surface displacement from occurring, no equipment or vehicles (except over-snow vehicles) would be permitted in the stream or drainage channels, except at designated crossing sites. If sinkholes are encountered, a no-entry 33 foot buffer strip around the outside edge of the feature would protect sinkholes. This would protect the side slopes from accelerated erosion and prevent increased water flow into the sinkholes.

No meadows have been identified within the treatment blocks. However if a meadow were encountered, a similar buffer zone with the same stipulations would be established.

Cumulative Soil and Water Effects
Alternative "C" would have negligible cumulative impacts on soil and water resources.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "C" would result in short-term negligible to minor adverse impacts to soil and water resources due to the reduction in overstory and the disturbance associated with treatment activities. Mitigation measures to protect long-term soil productivity and water resources associated with this alternative should be sufficient to prevent any long-term impact to soil and water resources.

III. ENVIRONMENTAL CONSEQUENCES

III. B. CULTURAL RESOURCES

III. B.1. AFFECTED ENVIRONMENT
Cultural resources of GRCA include historic and prehistoric archaeological sites, cultural landscapes, historic buildings, trails, monuments, and traditional cultural properties. Archaeological and historic properties reflecting human uses of areas from the Archaic period of time nearly 4,000 years ago, to historic uses related to early park development and the Civilian Conservation Corps (CCC) exist in the area of the experimental blocks.

The Grandview area of the South Rim was the location of considerable prehistoric and historic activity. Twenty-six archaeological sites have been documented within the area between the canyon rim and the boundary with the Kaibab National Forest. Projectile points indicating the presence of archaic period hunters have been found in the area, along with remains of later occupations primarily dating from AD 950-1150. Historic Native American uses of the area are also documented, primarily represented by temporary campsites that may be associated with the trade route between Hopi and Havasupai tribes.

Historic period sites in the project area document the earliest park development. The original stagecoach line from Flagstaff terminated in the Grandview area, and the first hotels at Grand Canyon were located near Grandview Point. The old Grandview Hotel and the Hance Ranch/Buggeln Hotel sites are located in the general vicinity of the Grandview experimental block. These hotels were the gathering places for visitors prior to the railroad reaching the South Rim in 1901.

Historic and prehistoric activities occurred on the North Rim as well. The majority of the sites found in the area of the project represent prehistoric camp or limited activity areas. Sites located on the southernmost plateaus of the North Rim are typically associated with Pueblo Period farming. Farming sites associated with ancestral pueblo people dated from AD 1050-1150 are common on the lower elevation plateaus of the area.

Historic activity in the area is generally related to Civilian Conservation Corps work of the 1930s. The remains of a large CCC camp and two "tree towers" are located north of the North Rim experimental block.

Archaeological surveys were completed for the Grandview and North Rim experimental blocks (80 acres each) at the 100% inventory level. One prehistoric site was located within the Grandview experimental block. AZ I:01:93 is a Native American site represented by the presence of artifacts and circular depressions dated ca. 1915-1930. Circular depressions found on site are likely the remains of wickiups. Concentrations of historic artifacts are scattered across the 43,020 square foot site area. Because this site is located on the control unit, this historic property would not be affected.

No archaeological properties were found within the North Rim experimental block.

III. B.2. METHODOLOGY

The assessment of impacts on cultural resources and historic properties was made in accordance with Advisory Council on Historic Preservation (36CFR 800) regulations implementing Section 106 of the National Historic Preservation Act. Following determination of the areas of potential effect, the areas were surveyed for cultural resources. All available information on known cultural resources was compiled. Where possible, map locations of sensitive resources were compared with locations of the proposed experimental blocks.

An assessment was made of the anticipated nature and extent of effects on cultural resources from implementing the alternatives. Cultural resources can be affected by actions that alter in any way the attributes that qualify the resources for inclusion in the National Register of Historic Places. Adverse effects can result when the integrity of a resource's significant characteristics is diminished. Consideration was given to both the effects anticipated at the same time and place of the undertaking, and to those potentially occurring indirectly at a later time and distance.

To provide consistency with requirements of NEPA, the effects on cultural resources are also described in terminology intended to convey the duration, intensity, and beneficial or adverse nature of potential impacts. Impacts could be of short-term, long-term or permanent duration. The thresholds of change for the intensity of an impact are defined as follows:

Negligible: Impact is at the lowest levels of detection - barely perceptible and not measurable.

Minor: Impact does not alter a character-defining feature of a National Register eligible structure, landscape, or district. Impact affects an archeological site(s) with low data potential and no significant ties to a living community's cultural identity.

Moderate: Impact is readily apparent and sufficient to cause a change in a character-defining feature(s) of a National Register eligible structure, landscape, or district, but not to the extent that the property is no longer eligible to listed in the National Register. Impact affects an archeological site(s) with modest to high data potential and no significant ties to a living community's cultural identity.

Major: Impact results in substantial and highly noticeable change(s) in a character-defining feature(s) of a National Register eligible structure, landscape, or district, to the extent that the property is no longer eligible to be listed in the National Register. Impact affects an archeological site(s) with exceptional data potential or that has significant ties to a living community's cultural identity.

Cumulative Impacts: The Council on Environmental Quality (CEQ) regulations, which implement the National Environmental Policy Act, require assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7).

Cumulative impacts were determined by combining the impacts of the proposed alternative with other past, present, and reasonably foreseeable future actions. Therefore it was necessary to identify other ongoing or reasonably foreseeable future actions within GRCA and, if applicable, the surrounding region.
In accordance with the Advisory Council on Historic Preservation's regulations implementing Section 106 of the NHPA (36 CFR Part 800, *Protection of Historic Properties*), impacts to cultural resources were identified and evaluated by: 1) determining the area of potential effects; 2) identifying cultural resources present in the area of potential effects that were either listed in or eligible to be listed in the National Register of Historic Places; 3) applying the criteria of adverse effect to affected cultural resources either listed in or eligible to be listed in the National Register; and 4) considering ways to avoid, minimize or mitigate adverse effects.

Under the Advisory Council's regulations a determination of *no historic properties affected*, *no adverse effect* or *adverse effect* must also be made for affected cultural resources. *No historic properties affected* means either there are no historic properties present or there are historic properties present but the undertaking will have no effect on them (36 CFR 800.4[d][1]). A determination of *no adverse effect* means there is an effect, but the effect would not diminish in any way the characteristics of the cultural resource that qualify it for inclusion in the National Register (36 CFR 800.5[b]). An *adverse effect* occurs whenever an impact alters, directly or indirectly, any characteristic of a cultural resource that qualify it for inclusion in the National Register, e.g. diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association. Adverse effects also include reasonably foreseeable effects caused by Alternative "C" that would occur later in time, be farther removed in distance or be cumulative (36 CFR Part 800.5, *Assessment of Adverse Effects*).

III. B.3. REGULATIONS AND POLICIES

National Historic Preservation Act of 1966
(PL 89-665, 80 Stat 915-919, 16 USC 470 et seq.)
This act established a federal historic preservation program. It authorized the Secretary of the Interior to: 1) instruct agencies to evaluate the effects of their undertakings on historic properties (Section 106); 2) expand and maintain a national register of districts, sites, buildings, structures, and objects significant in American history; 3) establish a program of matching grants-in-aid to states for historical preservation; and 4) establish a program of matching grants-in-aid to the National Trust for Historic Preservation. The act also established the Advisory Council on Historic Preservation. The Director of the NPS or his or her designee is to be the Executive Director of the Council. A 1980 amendment to this act places specific responsibilities on federal agencies in terms of historic preservation and the conduction of their own programs, planning and projects (Section 110).

Archeological and Historic Preservation Act of 1974
(PL 93-291, 88 Stat 174, 16 USC 469)
This act amended the Reservoir Salvage Act of 1960, and provides for preservation of significant, scientific, prehistoric, historic, or archeological data (including relics and specimens) that might be lost or destroyed as a result of: 1) the construction of dams, reservoirs, and attendant facilities; or 2) any alteration of the terrain caused as a result of any federal construction project, or federally licensed project, activity, or program.

Native American Graves Protections and Repatriation Act of 1990
(PL 101-601, 104 Stat 3048-3058, 25 USC 3001-3013)
This act requires federal agencies and institutions that receive federal funds to provide information about Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony to lineal descendants, Indian tribes, and Native Hawaiian organizations and, upon presentation of a valid request, dispose of or repatriate these objects to them.

American Indian Religious Freedom Act of 1978
(PL 95-341, 92 Stat 469)
This act declared "the policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express and exercise the traditional religions of the American Indian, Eskimo, Aleut, and Native Hawaiians, including, but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonial and traditional rites."

Executive Order 13007 on American Indian Sacred Sites, 1996
(61 FR 26771)
This order instructs all federal land management agencies, to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions, to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and to avoid adversely affecting the physical integrity of such sacred sites.

III. B.4. IMPACTS OF ALTERNATIVE "A" ON CULTURAL RESOURCES

Alternative "A" would have negligible impacts on cultural resources.

Cumulative Cultural Effects
Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Seemingly insignificant actions can add up (i.e., more and more of same type of action) or interact (i.e., various actions adding up to cause a new kind of impact) to cause impacts to the environment.

To properly determine cumulative impacts, a Reasonably Foreseeable Future Action (RFFA) analysis as referenced in 40 CFR 1508.7, should be used.

Alternative "A" would have negligible cumulative impacts on cultural resources.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "A" (no action) would have negligible short-term effects, and minor long-term impacts on cultural resources by not actively protecting cultural resources and would result in no historic properties affected. Long-term fire risk from accumulated fuels and dense thickets would increase and potential soil erosion and resulting damage to cultural resources would increase on experimental blocks.

III. B.5. IMPACTS OF ALTERNATIVE "B" ON CULTURAL RESOURCES

Alternative "B" would have negligible to minor impacts (archaeological or historic) on the experimental blocks. Archaeological surveys have been completed for all ground disturbing activities on both experimental blocks. If previously unknown archaeological resources are discovered, all work would be halted until the resources could be identified and documented and an appropriate mitigation strategy developed in consultation with the state historic preservation officer. If human remains were uncovered as a result of project implementation, all work in the area would cease until Native American Graves Protection and Repatriation Act requirements are met.

Cumulative Cultural Effects
Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Seemingly insignificant actions can add up (i.e., more and more of same type of action) or interact (i.e., various actions adding up to cause a new kind of impact) to cause impacts to the environment.

To properly determine cumulative impacts, a Reasonably Foreseeable Future Action (RFFA) analysis as referenced in 40 Code of Federal Regulations 1508.7, should be used. For the purpose of this analysis, it is assumed that all of the treatments outlined in Alternative "B", as described in this document, would be initiated.

Alternative "B" would have negligible to minor cumulative impacts on cultural resources. Prescribed fire may uncover presently unidentified cultural resources. These cultural resources would be recorded and studied if necessary. Negative cumulative impacts could result from increased recreational or educational use of the treatment areas. Increased use of the area near the experimental blocks could result in more vandalism to cultural resources. However, the potential for increased vandalism would probably be offset or negated by the greater presence of GRCA administrators, NAU researchers, and work crews for research and monitoring.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Implementation of Alternative "B" would result in no historic properties affected. A previously identified archeological site lies inside the control unit on the Grandview experimental block. No cultural sites are located on the North Rim experimental block. Mitigation measures associated with this alternative should minimize the impacts to any unknown cultural resources.

III. B.6. IMPACTS OF ALTERNATIVE "C" ON CULTURAL RESOURCES

Alternative "C" would have negligible to minor impacts (archaeological or historic) on the experimental blocks. Archaeological surveys have been completed for all ground disturbing activities on both experimental blocks. If previously unknown archaeological resources are discovered, all work would be halted until the resources could be identified and documented and an appropriate mitigation strategy developed in consultation with the state historic preservation officer. If human remains were uncovered as a result of project implementation, all work in the area would cease until Native American Graves Protection and Repatriation Act requirements are met.

Cumulative Cultural Effects
Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Seemingly insignificant actions can add up (i.e., more and more of same type of action) or interact (i.e., various actions adding up to cause a new kind of impact) to cause impacts to the environment.

To properly determine cumulative impacts, a Reasonably Foreseeable Future Action (RFFA) analysis as referenced in 40 Code of Federal Regulations 1508.7, should be used. For the purpose of this analysis, it is assumed that all of the treatments outlined in Alternative "C", as described in this document would be initiated.

Alternative "C" would have negligible to minor cumulative impacts on cultural resources. Prescribed fire may uncover presently unidentified cultural resources. These cultural resources would be recorded and studied if necessary. Negative cumulative impacts could result from increased recreational or educational use of the treatment areas. Increased use of the area near the forest blocks could result in more vandalism to cultural resources. However, the potential for increased vandalism would probably be offset or negated by the greater presence of GRCA administrators, NAU researchers, and work crews.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Implementation of Alternative "C" would result in no historic properties affected. A previously identified archeological site lies inside the control unit on the Grandview experimental block. No cultural sites are located on the North Rim experimental block. Mitigation measures associated with this alternative should minimize the impacts to any unknown cultural resources.

III. ENVIRONMENTAL CONSEQUENCES

III. C. PARK OPERATIONS

III. C.1. AFFECTED ENVIRONMENT

III. C.1.1. FIRE MANAGEMENT

Ponderosa pine ecosystems are considered to be well adapted to cyclic, low intensity burning, even though the parts have flammable properties. The resinous needles provide an abundant, annual source of highly flammable fuel, with yearly accumulations in dense stands exceeding 3,500 pounds/acre (USDA US Forest Service 1997a). Numerous references document the open, park-like appearance of historic ponderosa pine forests (Brown and Davis 1973). When single or small groups of trees fell, they were generally consumed by subsequent ground fires. This created a mineral soil seedbed and reduced grass competition in microsites, favoring ponderosa pine seedling establishment. These circumstances created an uneven-aged stand structure composed of small, relatively even-aged groups (Harrington and Sackett 1988). In these forests, herbaceous vegetation was abundant.

Fires were a regular occurrence in these forests, burning through light surface fuels at intervals usually averaging less than ten years and as often as every two years (Weaver 1951, Dieterich 1980). Change began in the Southwestern ponderosa pine forests during extensive livestock grazing in the late 19th century. As grazing intensified, herbaceous vegetation cover declined drastically. This decline led to two subsequent changes: reduced fire spread because of the decrease in fine fuels, and an eventual increase in ponderosa pine regeneration because of reduced competition with grasses and reduced fire mortality.

Beginning in the early 1900s, forestry practices, including fire control, further reduced the spread of fires, leading to unusually high fuel accumulations and stagnation of seedling and sapling thickets. The combination of heavy forest floor loadings and dense sapling thickets coupled with the normally dry climate and frequent lightning and human-caused ignition result in a severe wildfire threat (Harrington and Sackett 1988). Other problems resulting from the increased tree density, forest floor depth, and fuel loading in the Southwestern ponderosa pine forest can also lead to the following problems (Covington 1996):

1. decrease in soil moisture and nutrient availability;
2. decrease in net productivity and diversity of herbaceous plants and shrubs;
3. decrease in tree vigor, especially in the oldest age class of pine;
4. decrease in animal productivity;
5. decrease in stream and spring flows;
6. increase in susceptibility to pine bark beetles.

In addition, slowing rates of decomposition serve as an early warning sign of pathology in forest ecosystems. In ponderosa pine forests, the current accumulation of organic matter (litter, duff, and coarse organic matter)

indicates retarded decomposition and cycling, because the nutrients are locked in the form unavailable for utilization by plants. Pine litter and wood is rich in lignin, a general inhibitor of microbial activity. Fire accelerates nutrient cycling mainly by mineralizing nutrients, and fire exclusion inhibits this process (Rapport and Yazvenko 1995).

Results of fire scar analysis on other sites indicate that prior to 1876, fires occurred on an average of every two to twelve years in northern Arizona. However, fire return interval varies greatly from site to site according to site conditions and geographical area. Fire scar analysis of selected locations on the North Rim of Grand Canyon (Wolf and Mast 1998) indicates that pine forests burned every four to ten years prior to the suppression era which began in the early 1920s. Since 1919, the majority (77%) of fires in GRCA have been caused by lightning strikes. Most of the larger fires in the area occur during July and August. Suppression efforts now generally limit lightning-caused fires in the ponderosa pine type to a single tree or relatively small acreage.

This project would work in close coordination with the Fire Management Office, which supports the overall goals of this research project.

III. C.1.2. MAINTENANCE DIVISION

The Maintenance Division maintains roads in the Park including some that would be used by vehicles to access study sites.

III. C.2. METHODOLOGY

The three alternatives were evaluated for potential effects to Park Operations. Potential impacts were considered for Fire Management and Maintenance Division operations, including new or increased maintenance, interference with ongoing projects, and additional demands on staff time or funding.

III. C.3. REGULATIONS AND POLICIES

NPS Management Policies 2001

This volume is the basic service-wide policy of the NPS, focusing exclusively on the management of the national park system.

III. C.4. IMPACTS OF ALTERNATIVE "A" ON PARK OPERATIONS

III. C.4.1. FIRE MANAGEMENT

Alternative "A" would have minor to moderate short- and long-term impacts on fire management at GRCA. The ponderosa forest in the treatment areas would not be converted from a vegetation type with potentially high fire behavior to a vegetation type with comparatively lower fire behavior and intensities. Prescribed fire activities would continue in the Park but at a lesser frequency than would be expected with implementation of a full range of forest management prescriptions.

Cumulative Fire Management Effects

Alternative "A" would have negligible cumulative impacts on fire management. However, adverse indirect effects of Alternative "A" could stem from the Park's failure to test new forest management alternatives, and to consider those research findings in future resource management planning. Planning based on incomplete information could lead to more forestlands being damaged by wildfire and to more frequent closures of trails, campgrounds, and other areas due to wildfire risk.

Impairment

Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal

in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "A" (no action) would have minor to moderate short- and long-term impacts on fire management at GRCA.

III. C.4.2. MAINTENANCE DIVISION

Maintenance activities at GRCA would not be directly or indirectly impacted by Alternative "A". If the project did not occur, then there would not be an increase in traffic, and the access roads would not incur additional wear.

Cumulative Maintenance Effects
Alternative "A" would have negligible cumulative impacts on maintenance at GRCA.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "A" (no action) would have negligible short- and long-term impacts on maintenance at GRCA.

III. C.5. IMPACTS OF ALTERNATIVE "B" ON PARK OPERATIONS

III. C.5.1. FIRE MANAGEMENT

Alternative "B" would have negligible direct impacts on fire management activities because of the small size of the experimental units. A total of 40 acres would be prescribed burned under the full restoration treatment; 40 acres would be prescribed burned under the minimal thinning treatment; 40 acres would only be treated with prescribed fire; and 40 acres would serve as a control and would not undergo any treatment. Some previously scheduled prescribed fire projects may be delayed while prescribed fires are completed on the experimental units.

Alternative "B" would have minor to moderate indirect fire management activities after the completion of this study. The research conducted under this alternative would evaluate methods to address fuel management problems.

Cumulative Fire Management Effects
Alternative "B" would have negligible cumulative impacts on fire and forest fuel management.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "B" would result in a short-term minor positive impact to fire management, as fuel loads would be reduced on 120 acres. Alternative "B" would have long-term positive impacts on fire management by providing science-based information to guide future fire management planning.

III. C.1.2. MAINTENANCE DIVISION

Alternative "B" would have negligible to minor impacts on maintenance activities. The increased wear to the access roads caused by vehicle use may require more frequent road maintenance such as grading. Any need for road straightening or improvements could be mitigated by cutting timber to short lengths so it could be removed with small vehicles, so that improvements would not be needed.

Cumulative Maintenance Effects
Any road maintenance required for this alternative would be limited to a one-time action. Alternative "B" would have negligible cumulative impacts on maintenance at GRCA.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "B" would result in negligible to minor effects to maintenance.

III. C.6. IMPACTS OF ALTERNATIVE "C" ON PARK OPERATIONS

III. C.6.1. FIRE MANAGEMENT

Alternative "C" would have negligible direct impacts on fire management activities because of the small size of the experimental units. A total of 40 acres would be prescribed burned under the intermediate treatment; 40 acres would be prescribed burned under the minimal treatment; 40 acres would only be treated with prescribed fire; and 40 acres would serve as a control and would not undergo any treatment. Some previously scheduled prescribed fire projects may be delayed while prescribed fires are completed on the experimental units.

Alternative "C" would have minor to moderate indirect impacts on fire management activities after the completion of this study. The research conducted under this alternative would evaluate methods to address fuel management problems.

Cumulative Fire Management Effects
Alternative "C" would have negligible cumulative impacts on fire and forest fuel management.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "C" would result in a short-term minor benefit to fire management, as fuel loads would be reduced on 120 acres. Alternative "C" would have long-term benefits on fire management by providing science-based information to guide future fire management planning.

III. C.1.2. MAINTENANCE DIVISION

Alternative "C" would have negligible to minor impacts on maintenance activities. The increased wear to the access roads caused by vehicle use may require some road maintenance such as grading. The roads used to access study sites are regularly used by visitors to reach trailheads and enter the Park. The temporary increase in travel to carry out treatments and monitor treatment affects would represent a proportionately small increase to total road use. Any additional road maintenance required would be short-term and difficult to quantify.

Cumulative Maintenance Effects
Alternative "C" would have negligible cumulative impacts on maintenance at GRCA.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "C" would result in negligible to minor effect on maintenance.

III. ENVIRONMENTAL CONSEQUENCES

III. D. SOCIOECONOMIC RESOURSES

III. D.1. AFFECTED ENVIRONMENT

Park management practices could potentially affect the socioeconomic resources of several communities outside the Park and the Park itself. The three alternatives were evaluated for potential effects to socioeconomic resources.

III. D.2. METHODOLOGY

The three alternatives were evaluated for potential effects on the following socioeconomic resources: employment, traffic, population size of Park and surrounding communities, housing, Park infrastructure, and demands on water. Intensity levels for impacts to socioeconomic resources are defined as follows:

Negligible: impact is barely detectable and would not be of any measurable or perceptible consequence
Minor: impact is slight but measurable but the consequences would be small and localized
Moderate: impact is readily apparent and measurable but the consequences would be minimal
Major: impact is severely adverse or exceptionally beneficial

III. D.3. REGULATIONS AND POLICIES

NPS Management Policies 2001
This volume is the basic service-wide policy of the NPS, focusing exclusively on the management of the national park system.

III. D.4. IMPACTS OF ALTERNATIVE "A" ON SOCIOECONOMIC RESOURCES

Socioeconomic resources would not be directly or indirectly impacted by Alternative "A". There would be negligible change to the local economy because new work and new development would not occur. There would be no effect on the following socioeconomic resources: traffic, population size of Park and surrounding communities, housing, Park infrastructure, and demands on water.

Cumulative Socioeconomic Resources Effects
Alternative "A" would have negligible cumulative impacts on socioeconomic resources at GRCA.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "A" (no action) would result in negligible effects to socioeconomic resources.

III. D. 5. IMPACTS OF ALTERNATIVE "B" ON SOCIOECONOMIC RESOURCES

Our analysis did not identify adverse impacts to socioeconomic resources from Alternative "B". There would be no effect on the following socioeconomic resources: traffic, population size of Park and surrounding communities, housing, Park infrastructure, and demands on water. Alternative "B" would be beneficial to the local economy in two ways. First, it would employ contractors for a few months to cut and transfer timber. Second, it would benefit Native American tribes by providing fuel for home heating. The costs of treatment would vary depending on whether trees would be removed from the site and the number and size of trees to be cut. Lynch (2000) gives financial results for restoration projects in southwestern Colorado. Given the small scale and limited duration of proposed treatments, benefits or impacts to socioeconomic resources would be negligible to minor.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "B" would result in negligible to minor effects to socioeconomic resources.

III. D.6. IMPACTS OF ALTERNATIVE "C" ON SOCIOECONOMIC RESOURCES

Our analysis did not identify adverse impacts to socioeconomic resources from Alternative "C". There would be no effect on the following socioeconomic resources: traffic, population size of Park and surrounding communities, housing, Park infrastructure, and demands on water. Alternative "C" would be beneficial to the local economy by employing contractors for a few months to cut trees. A social service work agency, e.g., Coconino Rural Environment Corps or Americorps, would by contracted if possible; the crew would consist of primarily local hires. We estimate a crew of 8 would take 12 weeks to complete the project at a cost of approximately $50,000. Given the small scale and limited duration of proposed treatments, benefits or impacts to socioeconomic resources would be negligible to minor.

Cumulative Maintenance Effects
Alternative "C" would have negligible cumulative impacts on maintenance at GRCA.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "C" would result in negligible to minor effect on socioeconomic resources.

III. ENVIRONMENTAL CONSEQUENCES

III. E. VISITOR USE

III. E.1. AFFECTED ENVIRONMENT
More than 5 million people visited GRCA in 1996. About 22% of the public visit during the spring, 48% during the summer, 22% during the fall, and 8% during winter. Approximately 40% of the total visitors were from other countries. Most visitors travel with two or three other people, usually family members, and arrive in their own vehicles. Approximately 80% of the visitors stayed above the rims. About 650,000 visitors took air tours over the canyon in 1999.

Visitor use and experience activities that typically occur on the rims of GRCA include tent/trailer/small RV camping, viewing (nature, wildlife, cultural sites, canyon vistas, and astronomy), hiking, driving for pleasure, shuttlebus tours, mountain biking, backpacking, picnicking, cross-country skiing, visiting museums, music events, churches, and scenic attractions, attending classes, taking fixed wing aircraft and helicopter overflights, shopping at book and curio stores, photography, painting, attending ranger-led activities and interpretive lectures, limited horseback riding and guided mule rides, and enjoying wilderness settings or solitude.

The North Rim experimental block is adjacent to the non-wilderness Swamp Ridge road corridor. This road corridor is used to access remote trailheads that provide access to inner canyon backcountry areas. Approximately 4% of GRCA backcountry users may use this road to access trailheads, and less than 1% of backcountry users camp on the rim in the vicinity of the experimental block (2000 Backcountry Use Statistics on file, Science Center). The road is accessible from approximately mid-May to late October.

III. E.2. METHODOLOGY
The three alternatives were evaluated for potential impacts to resources used by visitors, such as forest lands used for hiking and camping, and access to trailheads or other park sites that would be affected. Intensity levels for potential impacts to visitor use and experience are defined as follows:
Negligible: impact is barely detectable and/or will affect few visitors
Minor: impact is slight but detectable, and/or will affect some visitors
Moderate: impact is readily apparent and/or will affect many visitors
Major: impact is severely adverse or exceptionally beneficial and/or will affect the majority of visitors

III. E.3. REGULATIONS AND POLICIES

NPS Management Policies 2001
This volume is the basic service-wide policy of the NPS, focusing exclusively on the management of the national park system.

III. E.4. IMPACTS OF ALTERNATIVE "A" ON VISITOR USE
Alternative "A" would have negligible short- and long-term impacts on visitor use. However, indirect effects of Alternative "A" could result if the Park fails to test forest management alternatives and consider these research findings during future resource management planning. Indirect effects of incomplete planning could result in damage to large areas of the Park from wildfire, and to more frequent closures of trails, campgrounds, and other forested areas due to wildfire risk.

Cumulative Visitor Use Effects
Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Seemingly insignificant actions can add up (i.e., more and more of same type of action) or interact (i.e., various actions adding up to cause a new kind of impact) to cause impacts to the environment.

To properly determine cumulative impacts, a Reasonably Foreseeable Future Action (RFFA) analysis as referenced in 40 Code of Federal Regulations 1508.7, should be used. Alternative "A" would have little if any direct cumulative impact to visitor use. However, the research outlined in the Alternatives "B" and "C" includes testing of specific prescriptions in ponderosa pine forest ecosystems. Should the cooperators fail to test and report on these prescriptions, other land managers would have fewer alternatives to consider in their own planning efforts. Failure to test the minimum-impact approaches outlined in Alternative "C" could also result in less effective and more intrusive management strategies being applied in the future.

Alternative "A" would have negligible cumulative impacts on visitor use.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "A" (no action) would have negligible impacts on visitor use resources.

III. E.5. IMPACTS OF ALTERNATIVE "B" ON VISITOR USE

Alternative "B" would have minor short- and long-term direct impacts on visitor use. Few people visit the locations of the experimental blocks. The visible evidence of marked trees, tree removal, cut stumps, burn piles, and operational noise would reduce the quality of natural and backcountry settings of GRCA in the short term. However, over time we would expect that these impacts would be offset and negated by long-term indirect effects such as increased vegetation diversity, "opening" vistas, and movement toward more natural and sustainable ecosystems.

Visual impacts associated with thinning and prescribed fire would be lessened by time and revegetation of sites with herbaceous and shrub species. Stumps would be cut flat and low to the ground and most would be from small young trees lacking the resinous heartwood of old trees. Most stumps and their associated small diameter slash would be consumed by prescribed fire. These effects would become increasingly difficult to distinguish within 10-30 years. Bark charring and the basal point spots used to mark small diameter save trees would begin to flake off even more rapidly. Although frequent, more natural burns would periodically darken the bark again, subsequent burns would leave less visual impact, because flame length would decline as the amount of forest floor fuels decreased, all other things being equal. Evaluation of methods to minimize visibility of treatment effects would be one of the objectives of this research project.

Cumulative Visitor Use Effects
Alternative "B" would have negligible cumulative impacts on visitor use resources.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "B" would result in short-term minor adverse impacts to visitor use resources. Visual resources would be impacted by the implementation of this alternative. Mitigation measures associated with this alternative should minimize these impacts. Alternative "B" would have negligible long-term impacts on visitor use resources.

III. E.6. IMPACTS OF ALTERNATIVE "C" ON VISITOR USE

Alternative "C" would have minor short- and long-term direct impacts on visitor use. Few people visit the locations of the experimental blocks. However, the visible evidence of marked trees, tree removal, cut stumps, burn piles, and operational noise would reduce the quality of natural and backcountry settings of GRCA in the short term. These impacts would be offset and negated by long-term indirect effects such as increased vegetation diversity, "opening" scenic vistas, and movement toward more natural and sustainable ecosystems.

Visual impacts associated with thinning and prescribed fire would be lessened by time and revegetation of sites with herbaceous and shrub species. Stumps would be cut flat and low to the ground and most would be from small young trees lacking the resinous heartwood of old trees. Most stumps and their associated small diameter slash would be consumed by prescribed fire. These effects would become increasingly difficult to distinguish within 10-30 years. Bark charring and basal paint spots used to mark small diameter save trees would begin to flake off even more rapidly. Although frequent, more natural burns would periodically darken the bark again, subsequent burns would leave less visual impact, because flame length would decline as the amount of forest floor fuels decreased. Evaluation of methods to minimize visibility of treatment effects would be one of the objectives of this research project.

Cumulative Visitor Use Effects
Alternative "C" would have negligible cumulative impacts on visitor use resources.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "C" would result in short-term minor adverse impacts to visitor use resources. Visual resources would be impacted by the implementation of this alternative. Mitigation measures (Appendix C) associated with this alternative should minimize these impacts. Alternative "C" would have negligible long-term impacts on visitor use resources.

III. ENVIRONMENTAL CONSEQUENCES

III. F. WILDERNESS

III. F.1. AFFECTED ENVIRONMENT

Approximately 1.1 million acres within GRCA are proposed for wilderness designation. This area includes most of the North Rim's forests (USDI National Park Service 1993). Management Policies (USDI National Park Service 2001, Chapter 6:3) require the NPS to ensure that the wilderness character and physical wilderness resources of proposed wilderness are preserved while the legislative process of wilderness designation is underway. In managing wilderness, the NPS adheres to the "minimum requirement" standard as expressed in Section 4c of the Wilderness Act:

> *Except as specifically provided for in this Act, and subject to existing private rights, there shall be no commercial enterprise and no permanent road within any wilderness area*

> *designated by this Act and, except as necessary to meet the minimum requirements for the administration of the area for the purpose of this Act (including measures required in emergencies involving the health and safety of persons within the area) there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure of installation within any such area.*

The Park Service interprets this statutory provision in Management Policies 2001 (Chapter 6.3.5) which states:

> *All management decisions affecting wilderness must be consistent with minimum requirement concept. This concept is a documented process used to determine whether administrative activities affecting wilderness resources or the visitor experience are necessary, and how to minimize impacts. The minimum requirement concept will be applied as a two-step process that determines:*
> *• Whether the proposed management action is appropriate or necessary for administration of the area as wilderness and does not pose a significant impact to wilderness resources and character; and*
> *• The techniques and types of equipment needed to ensure that impact to wilderness resources and character is minimized.*

The minimum requirement concept, described above, guides all management actions, including research, in wilderness and is intended to minimize impacts on wilderness character and resources (USDI National Park Service 1999a).

Finally, the NPS Management Policies mandate that park managers examine all administrative practices, proposed special uses, research and equipment use and apply the minimum requirement concept. The use of motorized equipment and the establishment of management facilities are specifically prohibited when other reasonable alternatives are available to protect wilderness character and resources (USDI National Park Service 1999a). Managers shall give both the physical and experiential qualities of wilderness appropriate consideration. Cost or convenience will not be primary factors in determining minimum requirement (USDI National Park Service 1999a, USDI National Park Service 2001).

In any case, the NPS recognizes and supports the value of wilderness areas as natural outdoor laboratories of both local and national significance. The increase of scientific knowledge, even if it serves no immediate wilderness management purpose, may be an appropriate wilderness research objective when it does not compromise wilderness resources and character. Research and other scientific use projects in wilderness must meet accepted protocols and standards (USDI National Park Service 1999a).

III. F.2. METHODOLOGY

A minimum requirement analysis was conducted to evaluate the potential impacts of the three alternatives to wilderness resources. Specific measures to reduce impacts were also explored throughout the Work Plan. These measures are discussed below in the impacts of the three alternatives. Intensity levels for potential impacts to wilderness are defined as follows:
Negligible: impact is barely detectable
Minor: impact is slight but detectable
Moderate: impact is readily apparent
Major: impact is severely adverse or exceptionally beneficial

III. F.3. REGULATIONS AND POLICIES

Wilderness Act
(PL 88-577, 78 Stat 890, 16 USC 1131 et seq.)
This act established the National Wilderness Preservation System, composed of Congressionally designated federally owned areas. Federal agencies are required to administer these areas to provide for their use and enjoyment, now and in the future, and to protect and preserve their wilderness character.

III. F.4. IMPACTS OF ALTERNATIVE "A" ON WILDERNESS

Alternative "A" would have negligible impacts on wilderness resources.

Cumulative Wilderness Effects
Alternative "A" would have negligible cumulative impacts on wilderness.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "A" (no action) would have negligible impacts on wilderness resources.

III. F.5. IMPACTS OF ALTERNATIVE "B" ON WILDERNESS

Alternative "B" would have negligible to minor direct impacts on wilderness resources. The increased activity associated with completing the treatments would impact wilderness values. However, these impacts would be extremely short-term in nature and limited to a small spatial area (80 acres). In addition, short-term impacts would occur from dust and smoke in the proposed wilderness area that could potentially affect opportunities for solitude. The study areas have been intentionally located next to publicly accessible roads in order to minimize disturbance.

A "minimum requirement analysis" was conducted to determine the minimum requirement needed to complete the draft Work Plan (Covington et al. 1998a). Through the minimum requirement analysis, it was determined that chainsaws would be used to complete the treatments of Alternative "B" on the North Rim.

Alternative "B" would help determine the effectiveness of fuel reduction strategies specific to GRCA. This information is urgently needed from GRCA, as past management history has been vastly different in the Park, where there has been minimal logging and grazing, than in other forests in the Southwest. This has resulted in a different forest structure within the Park. Given the different nature of the North Rim of Grand Canyon, research data from other areas may not be sufficient to determine the minimum amount of intrusion necessary for wildfire hazard reduction efforts. One of the primary purposes of this research would then be to determine which methodologies would result in the least intrusion in proposed wilderness areas if expanded efforts were deemed necessary.

Cumulative Wilderness Effects
Alternative "B" would have negligible cumulative impacts on wilderness resources.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal

in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "B" would have negligible short- and long-term impacts on wilderness resources.

III. F.6. IMPACTS OF ALTERNATIVE "C" ON WILDERNESS

Alternative "C" would have negligible to minor impacts on wilderness resources. The increased activity associated with completing the treatments would impact wilderness values. However, these impacts would be extremely short-term in nature and limited to the small spatial area of 80 acres. In addition, short-term impacts would occur from dust and smoke in the proposed wilderness area that could potentially affect opportunities for solitude. The study areas have been intentionally located next to publicly accessible roads in order to minimize disturbance.

A new "minimum requirement analysis" was conducted to determine the minimum requirement needed to complete the revised Work Plan (Appendix K). Through the minimum requirement analysis, it was determined that hand tools would be used to complete the preferred treatments on the North Rim.

Alternative "C" would help determine the effectiveness of fuel load reduction strategies specific to GRCA. This information is urgently needed from GRCA, as past management history has been vastly different in the Park (minimal logging, grazing, etc.) than in other forests in the Southwest. This has resulted in a different forest structure within the Park. Given the different nature of the North Rim of GRCA, research data from other areas may not be sufficient to determine the minimum amount of intrusion necessary for fuels reduction efforts. One of the primary purposes of this research would then be to determine which methodologies would result in the least intrusion in proposed wilderness areas if expanded efforts were deemed necessary.

Cumulative Wilderness Effects
Alternative "C" would have negligible cumulative impacts on wilderness resources. Alternative "C" would also greatly improve GRCA's ability to manage wilderness forest ecosystems for present and future generations. It would not prevent or delay proposed future wilderness designation of the experimental sites or surrounding lands. Service guidelines for identifying and designating wilderness resources are detailed in Reference Manual (RM) 41 (USDI National Park Service 1999a). Section 6.2.1 of RM 41 states that "An area will not be excluded from a determination of wilderness suitability solely because established or proposed management practices require the use of tools, equipment, or structures, if those practices are necessary to meet the minimum requirements for the administration of the area as wilderness." Furthermore, "Lands that have been logged, farmed, grazed, mined, or otherwise utilized in ways not involving extensive development or alteration of the landscape may also be considered suitable for wilderness designation if, at the time of assessment, the effects of these activities are substantially unnoticeable or their wilderness character could be maintained or restored through appropriate management actions."

Much of GRCA's forest has been severely altered by more than 100 years of fire exclusion. Thousands of acres of forests proposed as wilderness have been damaged by wildfires in recent years. The Park's rare old-growth forests remain at risk, both from wildfire and other deleterious effects of excessive stand density. It has become increasingly difficult in managing the Park's forests, to meet the dual mandates of the Organic Act and the Wilderness Act. This experiment is designed to be consistent with both policies, in that it would apply minimum tool concepts to develop and evaluate methods that the forest's "wilderness character could be maintained or restored through appropriate management actions." As previously stated, Alternative "C" would have negligible cumulative impacts on wilderness resources. However, the information gained through this experiment could have a substantial beneficial effect on future resource planning efforts both within and outside of the Park.

Impairment
Because there would be no major, adverse impacts to a resource or value whose conservation is: 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of GRCA; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or 3) identified as a goal in the park's general management plan or other relevant NPS planning documents, there would be no impairment of the Park's resources or values.

Conclusion
Alternative "C" would have negligible short- and long-term impacts on wilderness resources.

IV. CONSULTATION/COORDINATION

PUBLIC INVOLVEMENT
See "Scoping" (page 4) above.

Among the groups contacted were:

ENVIRONMENTAL GROUPS
Sierra Club – Flagstaff, AZ
Southwest Center for Biological Diversity – Phoenix, AZ
Southwest Forest Alliance – Flagstaff, AZ
Grand Canyon Trust – Flagstaff, AZ
Arizona Wildlife Federation – Mesa, AZ
Southern Utah Wilderness Alliance – Salt Lake City, UT

FEDERAL AGENCIES
U. S. Fish and Wildlife Service
Kaibab National Forest - Tusayan and North Kaibab Districts
Arizona Strip Field Office, Bureau of Land Management
US Senators: Honorable John McCain, Honorable Jon Kyl, Honorable Orrin Hatch, Honorable Robert F. Bennett, Honorable Harry Reid, Honorable Richard Bryan
US Representatives: Honorable J. D. Hayworth, Honorable Bob Stump, Honorable James V. Hansen, Honorable Chris Cannon, and Honorable John Ensign

STATE OF ARIZONA
Department of Environmental Quality
Arizona Game and Fish Department
Coconino County Supervisor
State Historic Preservation Officer

PRIVATE INSTITUTIONS
Museum of Northern Arizona

NATIVE AMERICAN TRIBES
Havasupai Tribe
Hopi Tribe
Hualapai Tribe
Navajo Nation
Pueblo of Zuni
Kaibab Band of Paiute Indians
San Juan Southern Paiute Tribe

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LIST OF EA RECIPIENTS

Copies of this EA have been sent to a wide variety of groups and individuals. This EA and a copy of the mailing list are available on-line at the project web site: *www.nps.gov/grca/forest/*.

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VI. GLOSSARY

Basal girdling: The action of cutting the tree's bark to the cambium layer in order to obstruct the flow of water and nutrients through the phloem and xylem and ultimately killing the tree.

Bole: A tree trunk.

Bud scorch: Discoloration or damage of the small protuberance on a stem or branch, which is often enclosed in protective scales, containing an undeveloped shoot, leaves, or flowers.

Cambium: A layer of cells in the stems and roots of vascular plants that generate phloem and xylem, which are essential for the life of the plant.

Categorical exclusion: A category of actions which do not individually or cumulatively have a significant effect on the human environment and which have been found to have no such effect in procedures adopted by a Federal agency in implementation of NEPA regulations. Neither an Environmental Assessment nor an Environmental Impact Statement is required for categorically excluded actions.

Char: To scorch or become scorched.

Crownfire: A fire whose source of fuel is concentrated in the foliage of the canopy.

Cumulative impacts: The accumulation of seemingly insignificant actions that cause impacts to the environment.

dbh: The diameter of a tree's trunk at breast height, usually 4.5 feet above ground level.

Duff: Decaying leaves and branches on a forest floor.

Ecosystem health: The state of a complete ecological system of an area that takes into consideration the state of plants, animals, and environmental factors (such as fire).

Ephemeral stream: A stream in which water flows seasonally.

Ground cover: Low-growing plants that form a dense, extensive growth and tend to prevent weed and soil erosion.

FARSITE: A fire area growth simulator; applies fire behavior models to complex environments and models: 1) surface fires, 2) crown fires, 3) spotting from torching trees, 4) point source fire acceleration, and 5) fuel moisture.

Fuel: Combustible dead and down trees, branches, needles, twigs, etc.

Irruption: An irregular increase in number.

Landscape scale: The entire area of land that consists of a type-specific ecosystem.

Leave trees: Trees that would not be thinned.

Litter layer: The uppermost layer on the forest floor consisting mainly of decaying organic matter.

Mosaic: Overlapping of one or more landscapes which form a composite landscape.

Mycorrhizal fungi: A type of fungi whose mycelium has symbiotic relationship with the roots of a vascular plant.

Non-native: A plant or animal species that is not indigenous to a specific landscape.

Perennial stream: A stream in which water flows all year long at all sites along the streambed.

Presettlement: The period prior to the settlement of North America by Anglo-Europeans, which was approximately the year 1870.

Replacement tree: A tree selected to replace a target or presettlement tree, not to be thinned.

Restoration: Bringing back a forest ecosystem to a prior, less-disturbed state (prior to the settlement of Anglo-Europeans).

Slash: Branches and other residue left on a forest floor after the cutting of timber.

Snag: A tree or part of a tree that is no longer living.

Steam bank erosion: The process of erosion along the sides of a stream's channel, causing material to be moved into and down the stream and causing the channel to widen.

Synergistic: When two or more substances or organisms achieve an accumulative effect of which each is individually incapable.

Target tree: A presettlement-age tree around which small diameter trees would be thinned in the minimal treatments.

Watershed: The region draining into a river, river system, or body of water.

VII. ACRONYMS

AGFD: Arizona Game and Fish Department

AQRV: Air Quality Related Values

BIA: Bureau of Indian Affairs

BLM: Bureau of Land Management

BMP: Best Management Practices

CCC: Civilian Conservation Corp

CEQ: Council on Environmental Quality

CFR: Code of Federal Regulations

DBH: Diameter at Breast Height

EA: Environmental Assessment

EPA: Environmental Protection Agency

GRCA: Grand Canyon National Park

GCVTC: Grand Canyon Visibility Transport Commission

GMP: General Management Plan

MRNG: Management Recommendation for the Northern Goshawk

NEPA: National Environmental Policy Act

NAU: Northern Arizona University

NRCS: U.S. Department of Agriculture's Natural Resources Conservation Service

NPS: National Park Service

PFA: Post Fledgling Family Area

PL: Public Law

$PM_{2.5}$: Airborne particles or droplets with a diameter less than 2.5 millionths of a meter (micrometer).

PSD: Prevent Significant Deterioration

RFFA: Reasonably Foreseeable Future Action

RM: Reference Manual

RMP: Resource Management Plan

SMZ: Streamside Management Zone

USC: United States Code

USDA: United States Department of Agriculture

USDI: United States Department of the Interior

USGS: United States Geological Survey

USFS: United States Forest Service

USFWS: United States Fish and Wildlife Service